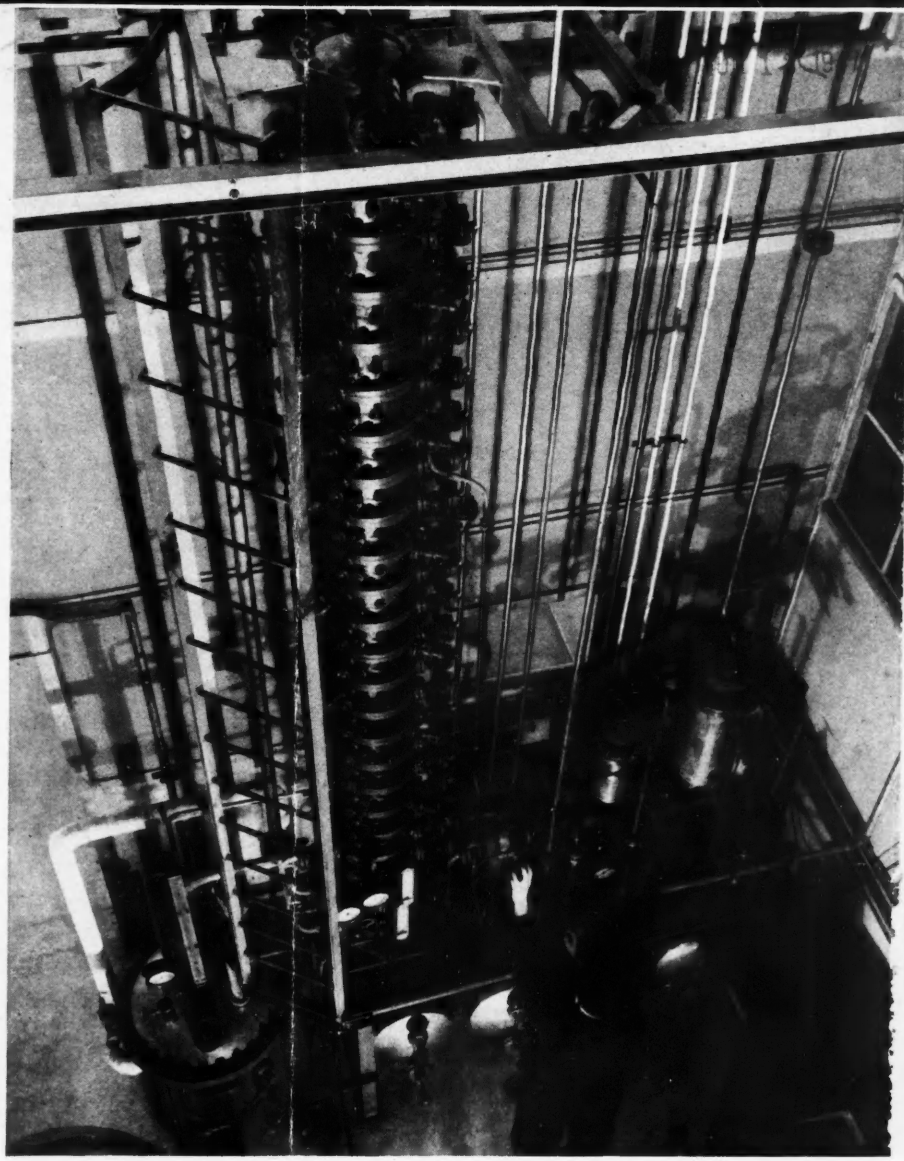
DISCOVERY



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The Progress of Science

A Scientist Rebels

THE political instability of the post-war world is reflected in the present pre-occupation of nearly all nations with matters of defence. This is affecting the world of science to a tremendous extent, an index of which is the high proportion of scientists now engaged on military research.

A very fine and courageous comment on the present situation whereby peace has come to look remarkably like what Roosevelt would have called "war without the shooting" was recently made by Professor Norbert Wiener of the Massachusetts Institute of Technology in a letter he wrote to a member of an aircraft company's research staff, and which has been published in *Atlantic Monthly*. Here is Professor Wiener's letter:

"Sir: I have received from you a note in which you state that you are engaged in a project concerning controlled missiles, and in which you request a copy of a paper which I wrote for the National Defense Research Committee during the war.

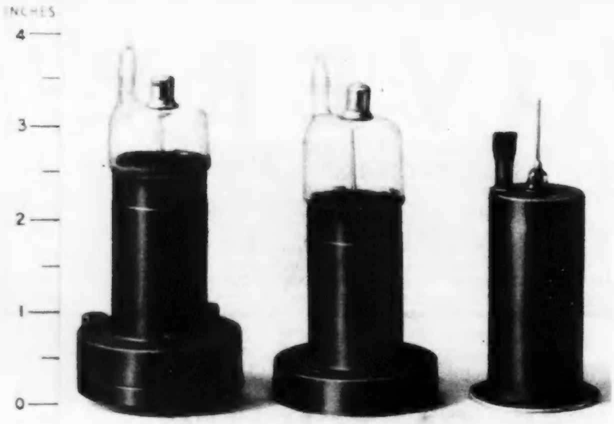
"As the paper is the property of a government organisation, you are, of course, at complete liberty to turn to that government organisation for such information as I could give you. If it is out of print as you say, and they desire to make it available for you, there are doubtless proper avenues of approach to them. When, however, you turn to me for information concerning controlled missiles, there are several considerations which determine my reply. In the past, the comity of scholars has made it a custom to furnish scientific information to any person seriously seeking it. However, we must face these facts: The policy of the government itself during and after the war, say in the bombing of Hiroshima and Nagasaki, has made it clear that to provide scientific information is not a necessarily innocent act, and may entail the gravest consequences. One therefore cannot escape reconsidering the established custom of the scientist to give information to every person who may inquire of him. The interchange of ideas, one of the great traditions of science, must of course receive certain limitations when the scientist becomes an arbiter of life and death.

"The measures taken during the war by our military agencies, in restricting the free intercourse among scientists on related projects or even on the same project, have gone so far that it is clear that if continued in time of peace this policy will lead to the total irresponsibility of the scientist, and ultimately to the death of science. Both of these are disastrous for our civilisation, and entail grave and immediate peril for the public.

"Of course, I am acting as the censor of my own ideas, and it may sound arbitrary, but I will not accept a censorship in which I do not participate. The experience of the scientists who have worked on the atomic bomb has indicated that in any investigation of this kind the scientist ends by putting unlimited powers in the hands of the people whom he is least inclined to trust with their use. It is perfectly clear also that to disseminate information about a weapon in the present state of our civilisation is to make it practically certain that that weapon will be used. In that respect the controlled missile represents the still imperfect supplement to the atom bomb and to bacterial warfare.

"The practical use of guided missiles can only be to kill foreign civilians indiscriminately, and it furnishes no protection whatsoever to civilians in this country. I cannot conceive a situation in which such weapons can produce any effect other than extending the *kamikaze* way of fighting to whole nations. Their possession can do nothing but endanger us by encouraging the tragic insolence of the military mind.

"If therefore I do not desire to participate in the bombing or poisoning of defenceless peoples—and I most certainly do not—I must take a serious responsibility as to those to whom I disclose my scientific ideas. Since it is obvious that with sufficient effort you can obtain my material, even though it is out of print, I can only protest *pro forma* in refusing to give you any information concerning my past work. However, I rejoice at the fact that my material is not readily available, inasmuch as it gives me the opportunity to raise this serious moral issue. I do not expect to publish any future work of mine which may do damage in the hands of irresponsible militarists.



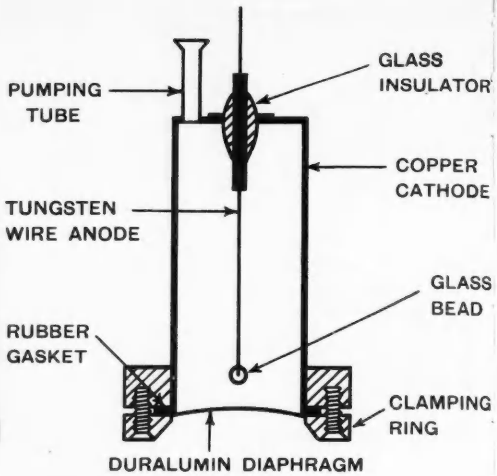


FIG. 1.—(*left*) Three modern types of Geiger counters. FIG. 2 (*right*) Section through third counter in Fig. 1.

"I am taking the liberty of calling this letter to the attention of other people in scientific work. I believe it is only proper that they should know of it in order to make their own independent decisions, if similar situations should confront them."

The general line of that letter we wholeheartedly support, and we are glad to have this opportunity of increasing its readership. We would, however, dissociate ourselves from the remark about "the tragic insolence of the military mind", which we have never encountered in this country, and which, even assuming it does exist, would be infinitely unimportant compared with the ambitions and insolence of nations as a whole.

The Geiger-Muller Counter

WE may soon expect the Geiger-Muller counter to become as familiar a piece of laboratory equipment as the chemical balance. Radioactivity measurements, such as those involved when using radio-isotopes, are becoming increasingly important, and the Geiger counter is the handiest instrument for such jobs. There is justification for *Time*'s description of the Geiger counter as "the watchdog of the Atomic Age".

Cosmic rays and all the radiations from radioactive substances have two properties in common. They cause gases through which they pass to become temporary conductors of electricity, and they affect photographic plates which then show blackening on development. (For details about the use of the photographic plate in the study of atomic particles, readers are referred to the article by Dr. R. H. Herz in the March 1947 issue of DISCOVERY.)

Most radioactive measurements are carried out using the first of these two properties, that of causing gases to 'ionise'. Four main types of instruments are used. These are:

1. *Ionisation chambers*, which are developments of the old but still useful gold-leaf electroscope which the Curies used in their classic investigations of radioactivity.

2. *Alpha counters*, in which the large number of ions formed by a single α-particle can carry a current sufficient to disturb an electric circuit, so that individual α-particles can be counted by counting the electrical disturbances in a given period.

3. *Proportional counters*; these have rather specialised applications and are not very much used.

4. *Geiger-Muller counters*.

The Geiger-Muller counter is sensitive to both β- and γ- rays, and because so many of the radioactive isotopes used in tracer experiments are β- or γ-active, the Geiger counter is nowadays the most commonly used instrument for making radioactive measurements. Like the α-counter and the ionisation chamber, the Geiger counter is simple in construction. On the other hand, unlike those two types of instruments, it is very complicated in the manner in which it functions.

The Geiger counter consists essentially of a small metal tube. A counter of typical design is illustrated diagrammatically in Fig. 3. The metal tube is about ten centimetres in length and two centimetres in diameter. It may be made of copper or aluminium. There is an insulated tungsten wire stretched along the axis of the tube, which is gas-tight and contains a gaseous filling. This filling sometimes consists of a pure gas, but more often it is a mixture of argon and alcohol vapour—about 94 per cent argon and 6 per cent alcohol—at a pressure of 10–12 centimetres of mercury.

The tube in Fig 3 has been machined at the centre until the metal is thin enough to allow β-rays to pass through the 'window' of thin metal so created. The outer tube of

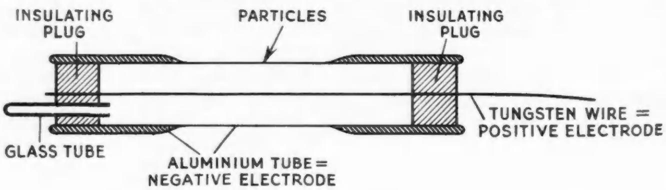


FIG. 3.—Diagram showing a typical Geiger counter design.

the counter is at a negative potential, relative to the central wire, of about 1200 volts.

A few words on ionisation are now necessary. An atom or molecule of a gas is ionised by any process which results in an electron being knocked out of an outer orbit so that a pair of ions is formed. The negative ion is the free electron, and the remainder of the atom or molecule constitutes the positive ion. The interaction between an atom of argon and a β- or γ-ray will result in the formation of an ion pair.

The electric field inside the Geiger counter is relatively weak near the outer tube and increases in intensity as we approach the thin central wire. If a β- or γ-ray passes into the counter one or more ion pairs are likely to be formed. The negative ions, being electrons, are small and highly mobile, and they move towards the positively-charged central wire with increasing speed due to the fact that the electric field increases in intensity the closer they approach the wire. The energy of the electrons becomes great enough before they reach the wire for them to be able to impart energy to atoms or molecules of the gas filling, and finally to cause secondary ionisation. Thus an electronic 'avalanche' is brought about, while other processes occurring at the same time tend to prolong the 'avalanche' effect. A single ion can initiate a discharge involving many millions of ions. The discharge can be made to operate a mechanical counting device.

To render the counter sensitive to another β- or γ-ray, one needs to be able to stop the discharge in the counter as soon as possible. The necessary 'quenching' of the discharge is usually carried out in one of two ways. Firstly, by the use of an external electronic quenching circuit, which cuts off the voltage applied to the tube almost as soon as the discharge has built up. Alternatively, and more frequently, a quenching agent is included in the gaseous filling of the counter; alcohol vapour, for instance, causes the discharge to stop soon after its initiation.

The discharge is initiated in much less than a micro-second (one millionth of a second), but the 'recovery time' for the counter is generally longer and depends on a

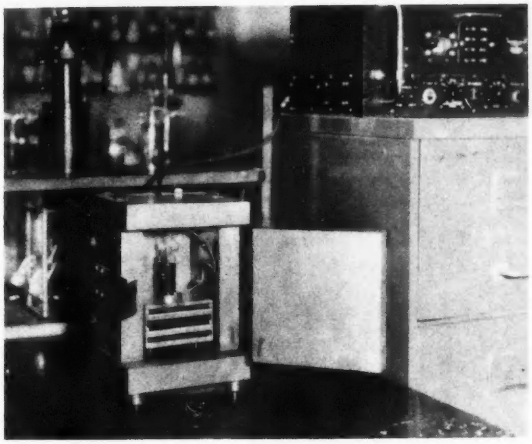


FIG. 4.—The Geiger counter records each particle given off by a radioactive sample placed beneath it. The counter is shielded by a lead 'castle' that protects the instrument from extraneous radiations which would otherwise be recorded. The scaling unit, which counts the electrical impulses coming from the counter, is seen at the top right-hand corner of the photograph.

number of factors. The total 'dead time' in which the counter is insensitive to the next β- or γ-ray arriving is the factor which limits the maximum counting rate of which the apparatus is capable. With a good counter working with a modern circuit arrangement a counting rate of 10,000 β-particles a minute is possible, and so few β-particles arrive during the 'dead time' and miss being counted that these can be neglected.

When a counter is being used merely to give warning of the presence of a radioactive source—as in the case of the 'clucking hen' used for recovery of radium needles mislaid in hospitals—the pulses from the counter are amplified and fed to earphones or a loud-speaker. The same kind of arrangement is being used today in connexion with the intensive prospecting for radioactive minerals (Fig. 5).

Readers interested in further details should consult the chapter on the Geiger counter in A. K. Solomon's *Why Smash Atoms?*

There is also something about the instrument in Frisch's chapter on the tools of nuclear physics in *Science News*, No. 2. For the expert it is perhaps unnecessary to give more erudite references than the following: C. G. Montgomery and D. D. Montgomery, *J. Franklin Inst.*, 1941, Vol. **231,** 447; and *Electron and Nuclear Counters*, by S. A. Korff, Van Nostrand, New York, 1946.

The instrument, of course, immortalises the name of Geiger who worked with Rutherford before the 1914–18 War. As first devised, to record the passage of single atomic particles, the apparatus was only able to count four or five particles a minute. It was Geiger who stepped up that figure by introducing various refinements. Today the mechanism of discharge in a Geiger counter is still not fully understood, but in the words of A. K. Solomon it is "an important and valuable instrument in nuclear research; now it is possible to hear a particle go by".

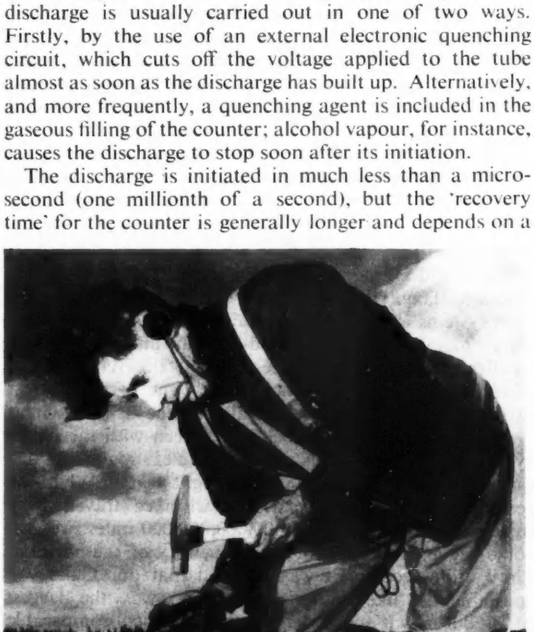


FIG. 5.—The portable 'clucking hen' type of counter which is being utilised in the search of radioactive minerals.

FIG. 6.—The 'migration' of carbon atoms in steel is being studied using the radioactive isotope, Carbon 14. The process is followed by means of a Geiger counter which records the β- particles given off in the disintegration of the Carbon 14 atoms.

Stranded Whales and Dolphins

"RECEIVERS of Wrecks and their Coastguard Officers have co-operated in a way that indicates an interest which is more than a mere compliance with official instructions." This remark, from the foreword to the Natural History Museum's report, written by Dr. F. C. Fraser, on cetaceans stranded on the British coasts from 1933 to 1937, is an acknowledgement of the contribution rendered to science by laymen in this connexion. The reporting of stranded whales, porpoises and dolphins is helping to clear up problems of distribution and questions of the relative abundance of the different species, as well as anatomical and physiological points. For the first time since such records have been kept the Euphrosyne Dolphin (*Prodelphinus euphrosyne*) turned up, at Croyde in Devon in 1937.

The number of stranded porpoises was ninety-two, the greater proportion from the English coast, with the biggest concentration about the Straits of Dover. Scottish strandings were very few considering the porpoise is not uncommon in Scottish waters. Strandings are most frequent in October, and least frequent in January. This fits in with the theory that there is migration towards the British coast reaching its peak in October.

One of the porpoises, washed up at Whitstable in 1935, had a Common Sole wedged in its throat, and this is suggested as the cause of death.

Thirty Common Dolphins were stranded during the period. It is thought that the scarcity of this species during the summer is due to its departure from our shores during its reproductive period. There was a remarkable number of strandings on the east coasts of Scotland and England during February, 1937. In 1935 the museum secured a specimen that had become entangled in mooring ropes and was found drowned at Putney Bridge; it was one of a small school that came up the Thames at the end of July.

Three White-sided Dolphins (*Lagenorhynchus acutus*) were stranded; these records came from Shetland, South Uist and near Scarborough. There were fourteen White-beaked Dolphins (*L. albirostris*), all from the east coast extending from Rattray Head to Broadstairs. The number of Bottle-nosed Dolphins (*Tursiops truncatus*) was twenty-one, concentrated on the south and west coasts of England.

Two Killer Whales are reported, one from Brighton in 1935 and the other at Havera Island, Shetland, in 1937. Two invasions by False Killers (*Pseudorca crassidens*) occurred, off South Wales in 1934 and off the North Sea coast in 1935, respectively.

Five Pilot Whales and ten Risso's Dolphins (*Grampus griseus*) were stranded.

Sperm Whales numbered three. The first of these records, in 1934, came from the Coastguard Station at Kimmeridge. In 1937 a male Sperm Whale fifty-nine feet long was stranded at Bridlington. (A month later two specimens were stranded on the Dutch coast, and it was suggested by Dr. Fraser that the occurrence of the whales and of the Common Dolphins in the North Sea was associated with an invasion of cuttlefish that happened at that time.)

Only five specimens of Cuvier's Whale (*Ziphius cavirostris*), an Atlantic species which approaches Britain from the west, were reported, and these strandings took place on the west coasts of Scotland and Ireland. The numbers of Bottle-nosed Whales, True's Beaked Whales, Sowerby's Whales and Lesser Rorquals were respectively 5, 1, 1 and 8.

A valuable feature of this report is a key for identifying British whales and dolphins.

The Universe Beyond Us

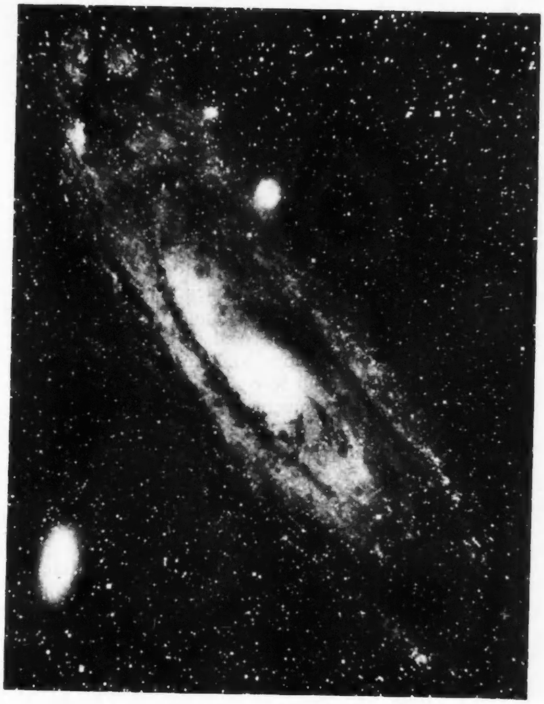
THE sun and all the stars we can see on any night belong to our Galaxy, which is merely one of many millions of such systems. The Galaxy contains about 100,000 million stars—many much larger than the sun and many much smaller, but on the whole the sun is a fair average of the stars both in size and temperature. One of the nearest extra-galactic systems or spiral nebulae is the Great Nebula in Andromeda, which can be seen with the naked eye as a faintly luminous cloud on a clear night. Its distance from us is about 850,000 light-years. When we remember that a light-year—the distance travelled by light in a year—is nearly 6,000,000,000,000 miles, we gain some vague conception of the immensity of the universe. Until quite recently it was believed that our Galaxy (a spiral nebula like millions of others) was the largest of all, but now it appears that there are others comparable with it in size, and perhaps some will be discovered which are much larger.

A problem which has exercised the minds of astronomers for some years is the total number of extra-galactic nebulae and also the number, on the average, which exists in a certain volume of space. The unit of length in dealing with

these vast distances is known as the *megaparsec*. Without going into lengthy explanations, the megaparsec is a little less, in miles, than 2 followed by 19 noughts. This is the same as 20 million million million miles or 3¼ million light-years. A cubic megaparsec, the unit of volume, is simply a cube, each edge of which is the length just given. How many spiral nebulae are there, on the average, in this volume?

Until recently the figure usually accepted was six, but now it seems that this is an under-estimate. Dr. Alan Fletcher of the Department of Applied Mathematics at Liverpool University has a paper in the *Monthly Notices of the Royal Astronomical Society* (Vol. 106, No. 2), in which he points out that there is an error in the method adopted for calculating the number of these nebulae, and shows that it is practically twice that which has been usually accepted. The paper is highly technical and would not be easily understood by non-mathematicians, but we can accept Dr. Fletcher's results as substantially correct.

The 100-inch telescope at Mount Wilson is capable of visually detecting spiral nebulae about 500 million light-years away, and the 200-inch reflector will probably penetrate to a distance of 1000 million light-years. It has been estimated that these telescopes are respectively capable of detecting 2 and 8 million spiral nebulae, but with the aid of photography they could reveal many times these figures. A sphere with a radius of 1000 million light-years—about 307 megaparsecs—has a volume of 120 million cubic parsecs. Allowing twelve spiral nebulae for each cubic parsec, the number of nebulae that could be photographed with the 200-inch reflector would be nearly 1500 million. We make no estimate of the time that would be required to complete such an astronomical survey.



Spiral nebula in Andromeda. (*Yerkes Observatory.*)

Sheffield University and the War

THE scientific highlights of the last war are, presumably, by now well known. But many minor contributions, which added together played a big part in hastening victory, are only slowly coming to light. And as they do, we begin to get a truer picture of war science and see how it entered in various degrees into almost every aspect of our war effort—sometimes revolutionising a fighting technique or a production industry, sometimes modestly providing a setting instrument which added one per cent to the output of some essential commodity.

One cross-section of this all-pervading scientific activity is given in a recent report on Sheffield University's war work. The scientists of Sheffield took their part in the spectacular achievements. Their Physics Department worked on the design, development and production of the special permanent magnets required for the 'Magnetron' valve, the key to high-precision radar. Their chemists had a share in the researches that turned RDX into a practicable war explosive.

But it is more interesting to note here the smaller contributions which additively must have been just as important. Charcoal for shell fuses was formerly made from specially imported woods. When these sources were cut off, the Sheffield botanists helped the Ministry of Supply to survey British resources of the Alder Buckthorn (*Rhamnus frangula*). They tracked down the causes of variations in the quality of the charcoal, and the work led to the design of a new kiln, with which it was possible to eliminate the worst irregularities. The botanists also did their share in developing camouflage methods. Members of the Zoology Department showed that scabies is not transmitted by bedding and clothing as was formerly believed, but by personal contact; this led to the development of new remedies, and at the same time to the elimination of the waste involved in useless precautions. The zoologists also worked on the biology of the grain weevil that destroys grain stocks, and they helped to discover conditions that would minimise the damage it does. The biochemists took part in the investigations which were necessary before 'National Wheatmeal' bread could be safely introduced.

Sheffield's geologists discovered that the sand of Loch Aline could replace the special sands formerly imported from the Continent for the manufacture of optical glass. The Department of Glass Technology helped to develop kinds of glass for use at extremely low temperatures, as well as laminated glass for bullet-proof goggles and specially toughened glass to resist the effects of explosions. The Mathematics Department wrestled with the extremely complex problems involved in the manual control of instruments for following targets.

There was work, too, that did not reach fruition during the war, but which holds promise for the future—such as that of the Department of Pathology on traumatic shock. Their work, which took the scientists very near the front line, did not lead to any new treatment, but the knowledge they collected cannot fail to help future researches on these lines.

Besides research, the scientific departments helped in numerous other ways. The Department of Geology ran an advisory service to help local industries to find new sources of raw materials, and similar work was done by the Department of Refractories. Numerous special instructional courses were run for industrial operatives and Servicemen. The Engineering Department made a significant and direct contribution to production—in the critical summer of 1940 staff and students worked three shifts a day, seven days a week, heat-testing 3000 forgings for tank parts and enough steel sheet for 45,000 helmets. At a later stage they produced nearly 2,500,000 components for the Sten gun and for aircraft engines. Women students numbering 178 undertook spare-time work assembling fuses, of which they turned out 385,000 in all. We have mentioned only a few samples of the work done, and we have said nothing of the members of the staff who served with the Forces or were seconded to Government Departments, nor of the contribution to the war effort resulting from the special adaptation of the normal educational functions of the University.

The Importance of Shape

Professor Linus Pauling of the California Institute of Technology, who recently received the coveted Willard Gibbs Medal, has expressed his opinion that the next twenty years will see as great advances in biology and medicine as the past twenty brought in chemistry and physics. He bases this forecast on his belief that, for many of the basic problems of biology, the answer lies in greater knowledge of molecular structure and intermolecular reactions. Among such problems of fundamental importance are the nature of growth, the mechanism of the duplication of genes, the action of enzymes, the mode of action of drugs, hormones and vitamins, and the structure and action of nerve fibres.

The shapes of molecules, he considers, are of great importance, and it is the growing realisation of this point, coupled with improved technical experimental methods for studying them, that gives support to his belief in the forthcoming era of biological progress. Visual observation with the ordinary microscope has enabled structures down to 10^{-4} centimetres to be studied, while the electron microscope has now pushed the lower limit down to 10^{-6} centimetres.

The gap between 10^{-6} and 10^{-7} centimetres is now being narrowed, and one hopes that it may soon be closed by means of electron microscopes of higher resolving power and by more refined methods of diffraction analysis. The larger molecules, such as proteins, fall into this gap in the scale, and the elucidation of a high proportion of biological properties awaits a real understanding of the structure of the protein molecule. At present, a fairly complete list can often be drawn up of the different types of building unit which go to make up the molecule of a particular protein, while the approximate number of each unit and the approximate weight of the whole molecule may be known, and frequently one has also a rough idea of the shape of the protein (e.g. whether it is spherical or fibrous). But accurate knowledge of the order in which the units are joined, and the finer points of the manner of their inter-connexion and of the exact shape of the whole, is still largely unknown. It is rather like trying to imagine the construction and working of a complicated machine given only a rough catalogue of components which can be fitted together in an almost unlimited number of ways.

Most of the biochemical changes which take place in the living cell appear to be surface reactions. That is to say, it is considered that one or more molecules must arrange themselves on the surface of another molecule (usually a protein) before a chemical change can take place, and after the chemical reaction has occurred the products of the reaction leave the surface which is then available for the same thing to occur again. Very high specificity is frequently shown in physiological phenomena: a very slight change in the structure of a drug may completely abolish its activity; an animal may die of some nutritional deficiency even though it is being supplied with an adequate amount of a nutrient which differs only from the essential one in being a mirror image, an optical isomer, of it. An enzyme, urease, which acts as the protein surface on which the decomposition of urea occurs, will split urea but no other known compound. It appears that when the components come together, not only must the forces of attraction between them be suitable, but a 'close fit' is required; if one component is not quite the right shape, no reaction occurs.

It follows that it might be possible for one substance to be substituted for another if both had a very similar shape, and properties which were not too different. This has been found to be the case, and an outstanding example is afforded by sulphanilamide (M & B 693), which has almost exactly the same shape as *para*-aminobenzoic acid, a substance essential for the nutrition of certain bacteria. Sulphanilamide is believed to function by taking the place of *para*-aminobenzoic acid in one of the enzyme systems of the bacteria, and by blocking it, preventing the proper nutrition of the bacteria, so leading to their death. This hypothesis has been followed by an intensive study of essential growth factors of bacteria in the hope that, when their shape and structure are discovered, it will be possible to destroy the bacteria by a suitable substitute.

While there is a considerable understanding of the mechanism of vision and hearing, very little is understood concerning the senses of taste and smell. The eye and ear can be treated as instruments for the reception and analysis of forms of wave motion, but it appears that direct contact has to be made between the taste buds of the tongue or the olfactory membrane of the nose and the substance being perceived, and there is no agreement yet as to whether these receptors are reacting to some physical or to some chemical property of the molecule. As it is probable that surface phenomena are involved, shape may play an important part here too, and Pauling believes that two substances may well be found to have similar tastes or smells if they have the same shape, even if they are unrelated chemically.

In the past, much attention has been given to the isolation of natural products and to the study of their chemical structure and properties. It now remains to fill in the details of the fine structure and shape, and then perhaps we shall begin to reap the rich harvest forecast by Pauling.

The Vavilov-Lysenko Controversy

An editor's post bag is a constant source of surprises. After Hiroshima and Nagasaki, we expected to receive at least one letter commenting on the implications of war-time developments in atomic energy. But no; not a single letter on the subject ever reached this office. When we published Dr. Darlington's recent article we again expected a correspondence to follow, and this time our expectations were not disappointed. So large indeed was the correspondence that we could have produced a special supplement and called it *Modern Quarterly*. For the reason that the letters largely duplicated each other, and for no other reason, we could not publish them all and we were forced to select a few of these letters for publication. This has been no random selection; we took particular care to publish those letters which refuted most strongly the views expressed by Dr. Darlington.

Incidentally, as some readers appear to misunderstand the function of an editor, we would add that we took no more and no less responsibility for Dr. Darlington's article than for any other signed article published by us.

The article itself has not gone unnoticed by the British press, and it has also aroused interest in many other parts of the world. So far no geneticist has attempted to reply to the charges that Dr. Darlington made, though we would be ready to publish an article, should anyone be found who is prepared to defend Lysenko's position. We need hardly say that we would welcome a reply from Lysenko himself. For any other potential author we are prepared to waive the condition that he should have read Lysenko's book from which Dr. Darlington not unfairly quoted.

We would, however, remind any potential author of Professor Haldane's remark, broadcast in a recent Third Programme talk and printed in *The Listener* of April 3: "I suppose Russell is referring to the Russian biologist, Lysenko, who has peculiar views on how to breed wheat. I do not agree with all of them." As that remark was made in a radio talk it is likely that it represented under-statement rather than over-statement of Haldane's views.

The general confusion which persists in this controversy has been added to by a remarkable letter published in *The Spectator* of April 11. The letter writer, one I. M. Billik, contradicts a reference to Vavilov's death with the claim: *As everyone who is following the scientific life in Russia knows, S. I. Vavilov is still the president of the Russian Academy of Sciences, and Prof. Lysenko, his opponent . . . one of the vice-presidents . . . only a few weeks ago the same 'arrested and executed' Vavilov published an article about the work of the Academy of Sciences—to which "Pravda" . . . devoted two half-pages.* We need hardly point out that this is a complete red herring. Sergei Vavilov, who is president of the Academy of Sciences, is a physicist well known for his researches on fluorescence. The Vavilov involved in the Lysenko controversy was Nikolai Ivanovich Vavilov. The only excuse for confusing the two men is that they were brothers.

"The Beginning or the End"

This film is not as bad as the American critiques which reached this country ahead of it had suggested. It is streets ahead of the ridiculous radar film, *School for Secrets*. It is the only feature film in existence dealing with the subject of atomic energy, and in the absence of anything better it ought to be recommended to the ordinary public. But to recommend it for the general public is not to overlook the film's faults. Its worst fault is dullness, in many ways the worst sin the cinema can commit. Another error was to introduce a love interest, which is even more insipid than it is irrelevant. (The synopsis provided at the press show said, "In Washington Brig. Gen. Leslie R. Groves is assigned to command the costly project, with Jeff Nixon as his aide. This leads to a heightening of romantic interest between Jeff and Jean O'Leary, confidential secretary to General Groves." Which expresses briefly the incongruity with which Love and Los Alamos are brought together in the film!)

Certain sequences are likely to create a deep impression among any audience. The climax is extremely well done —the flight to Hiroshima, the dropping of the bomb, the horror that clouds the face of every airman in the plane as he realises, for the first time, the damage the weapon can do. As the critic of the *Bulletin of the Atomic Scientists* wrote, this scene "is extremely effective (by far the best in the picture) and it cannot fail to leave an impression. I believe that the American people will receive from the picture at least some indication as to what an atomic bomb attack may be like." For the British public it seems likely that this sequence will carry more conviction than the newsreels which showed the explosions of real bombs at Los Alamos and Bikini.

The impersonation of characters like Einstein, Fermi and Vannevar Bush becomes at times rather embarrassing. The best impersonation in the film is certainly that of Roosevelt, while our atomic-scientist friends say that the portrait of General Groves errs on the side of flattery. The outstanding character in the film is a junior scientist called Matt Cochran, who never solved the ethical considerations of working on the atomic bomb until after it had killed him. (This last point represents a telescoping of history which was probably justifiable.) Unfortunately Matt denies his own doubts and leaves behind him a last testament suggesting that everything connected with atomic energy will work out right in the end: "Atomic energy is a hand God has extended." The director apparently thought it unwise to raise any feeling about international control of atomic energy, and the only philosophy to emerge from the film was that "everything will be all right if we keep on keeping on". Which, truth to tell, is the most common attitude towards atomic energy, and in this respect the views expressed in the films are no worse and no better than the average.

After seeing it one is tempted to wonder how a more powerful atomic film could be made. There is no doubt that such a film is needed. One gets the impression that M.G.M. took the film very seriously, but paid more attention to details that do not matter than to the general impression they were creating. Could it have been done better by a documentary producer? Perhaps, though one wonders whether the film would then be shown in ordinary commercial cinemas. One would expect a film much better than *The Beginning or the End* to come from a producer like Louis de Rochemont, the March of Time producer who has perfected a technique of stylised realism which he used to great effect in *Boomerang* and 13 *Rue Madeleine*.

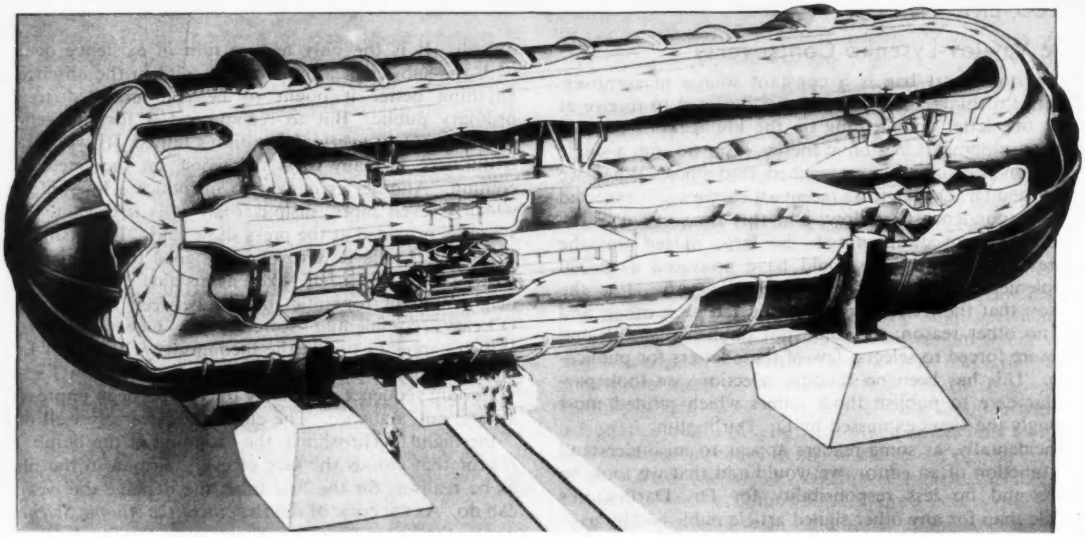


FIG. 1.—One of the latest tunnels to be built, the R.A.E. High Speed wind tunnel, is capable of producing an airstream at four-fifths the speed of sound—600 m.p.h. Its similarity of outline to the Compressed Air Tunnel (see Fig. 6) is due to the fact that it also has an airtight outer shell, but in this case the tunnel usually works with an internal pressure of a sixth of an atmosphere. (*Crown Copyright.*)

Wind Tunnels

J. BLACK, M.Sc.

AERODYNAMICS is derived from the older and well-developed subject of hydrodynamics, and it is possible to obtain a reasonably accurate analysis of the flow of air past simple shapes, such as cylinders and spheres, from purely theoretical considerations. With so complicated a body as an aeroplane, however, this is quite impossible and some experimental method is called for, both to verify new theories and to provide immediate knowledge about developments in design which follow.

When an airstream passes over a body there are three major points of interest which arise:

(*a*) the forces which are being exerted on the body by the air;
(*b*) the pressure distribution round the surface of the body; and
(*c*) the effect of the body on the motion of the air as it flows past.

The first of these has engaged the attention of experimental workers from the earliest days, as it was naturally the one most fundamental in the attempt to get a heavier-than-air machine off the ground.

The first results for the lifting force and resistance to motion, or drag, of surfaces at different angles were obtained by Sir George Cayley (1773–1857), the much neglected 'Father of Aeronautics'. He used a 'whirling arm', an apparatus consisting of a horizontal arm which could be rotated about a vertical pillar: the plate being examined was fastened to the end of the arm, and the force produced on it as it whirled through the air could be measured.

However, it was not until 1889 that Lilienthal, in Germany, made practical use of results on lift and drag of curved plates obtained on a whirling arm (Fig. 2) in which the rotation was produced by descending weights. From these results he was successful in building and flying a man-carrying glider.

This type of apparatus, with elaborations, was also used, about ten years later by Langley in America. Another arm, from which extensive information was obtained, has been in continuous use at the National Physical Laboratory from the same period. The N.P.L.'s new whirling arm was figured in DISCOVERY a year ago (May, 1946, Vol. 7, No. 5, p. 143).

The disadvantage of the method is that after one rotation the body is moving through the disturbed air in its own wake. Moreover, owing to the rotation of the arm the whole mass of air surrounding the arm will gradually start rotating as well.

An investigation into the drag of flat plates, cylinders and spheres was made by Eiffel in 1907. He followed in Galileo's footsteps by letting the bodies fall freely from a height. The model was fastened to a small frame which included a spring balance, a coupled tuning fork and recording drum: the whole frame, with the model projecting downwards, was then released to slide down a wire

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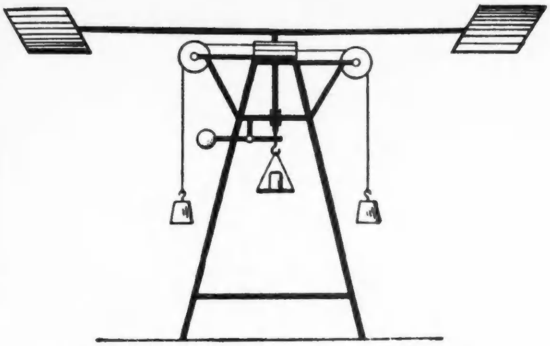
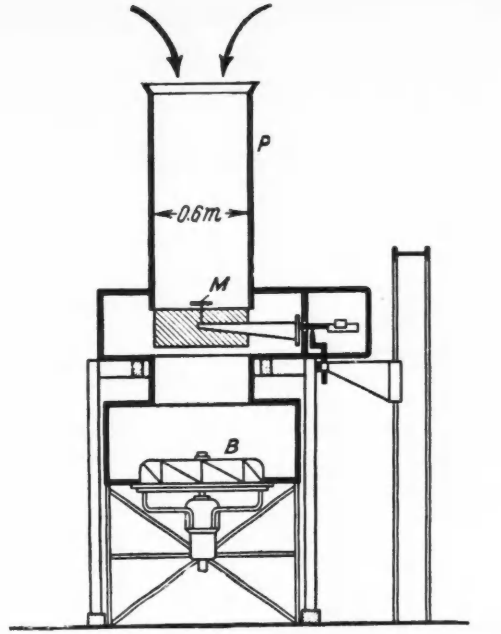


FIG. 2 (*above*).—Whirling arm used by Lilienthal in 1889 to measure the lift and drag of curved plates. The plates under investigation were mounted at the ends of the arms, rotation of which was produced by the descending weights. The lifting force exerted by the plates was weighed out on the small balance arm. FIG. 3 (*right*).—Early wind tunnel of Sir Thomas Stanton erected at the National Physical Laboratory in 1903.



stretched vertically from the top of the Eiffel Tower. The trace of the tuning fork indicated the maximum extension of the balance, and hence the drag. Speeds up to 130 feet per second were reached.

It was soon realised that both these methods were very limited, and that an apparatus allowing for more continuous study under controlled conditions was called for.

Artificial Airstreams

As the quantities being examined remain the same whether the air is at rest while the body moves, or vice versa, it is clear that the most useful way of investigating airflow is to create an artificial airstream, and fix the body in it. This is what is done in a wind tunnel.

The advantages of this method are many: the experiment can be carried on for some time without appreciable changes in the conditions of the test, the flow can be made uniform over the whole body, and all measuring apparatus and instruments can be located conveniently outside the airstream thus causing a minimum of interference with the model.

While the Wright brothers in their intense experimental period 1900–2, used an elementary form of wind tunnel, with a sixteen-inch square airstream, the first one to be built as a proper piece of laboratory apparatus was that of Sir Thomas Stanton at the National Physical Laboratory in 1903 (Fig. 3).

This consisted of a vertical tube (*P*), two feet in diameter, down which air was sucked by a ventilating fan (*B*) attaining a maximum velocity of thirty feet per second. The model (*M*) was mounted to one arm of a sensitive scale by means of a thin strut, so that the force on it could actually be weighed.

The next wind tunnel of note was that of Riabouchinsky, erected in Moscow in 1906. This was similar in principle to that of Stanton's, but was four feet in diameter, with cylindrical walls of glass at the section where the model was mounted, in order that it could be observed with the air flowing past. One noteworthy new feature was the introduction of a number of honeycomb grids at the tube inlet, whose function was to smooth the airstream, and bring it to a uniform velocity at all points in its cross-section.

By 1910 the basic form of the wind tunnel as we know it today had been evolved by Prandtl, at Gottingen, and Stanton at the National Physical Laboratory (Fig. 4), with the introduction of the return circuit. In this, the air leaving the fan is passed into a channel which returns it back to the inlet again, with the result that any energy it possesses is not dissipated, but contributes to the working stream. Once the air has been set into motion, therefore, the fan has only to overcome the frictional losses in the ducts, with a consequent saving in power.

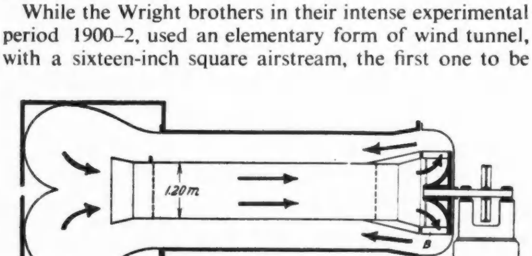


FIG. 4.—Return-flow closed-jet tunnel of Stanton, built at the N.P.L. in 1910. The similarity of outline to the modern compressed-air tunnel, and high-speed tunnel is striking, as the method of continuously circulating the air is the same. Air is sucked along through the 'working section' by the fan (B) after which it returns to the inlet through the annular passage surrounding the working section.

The standard type of tunnel used in England from about 1919 up to 1930 did not make use of this principle, however, as in that stage of development it tended to produce pulsations and turbulent airflow. The N.P.L. tunnel, as it was called, was identical in essentials to Stanton's earliest one, the differences being that the whole tunnel was mounted horizontally

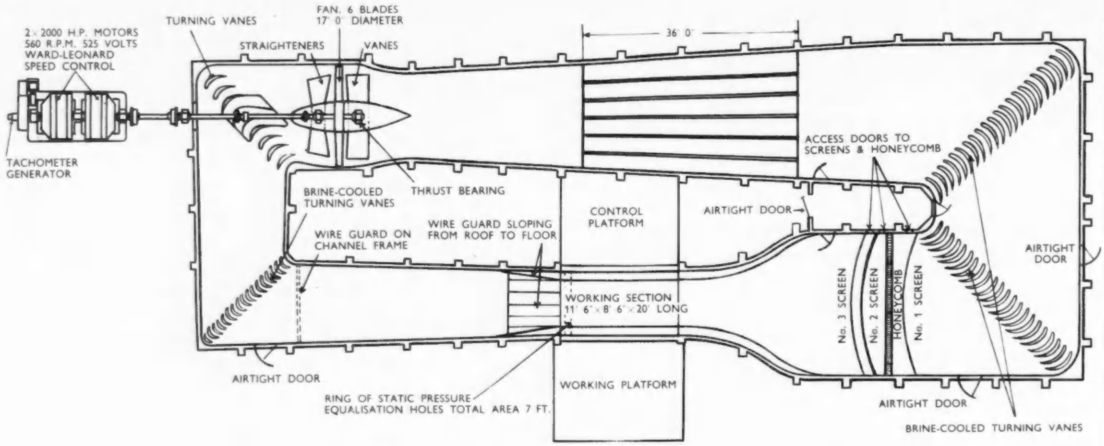


FIG. 5.—Plan view of the No. 2 (11½ × 8½ feet) wind tunnel at the Royal Aircraft Establishment, Farnborough. This may be taken as typical of modern high-performance wind-tunnel design, noticeable features being the long diverging passage from the fan, and the large ratio of contraction of the stream down to the working section.

in a large hall, and was of rectangular cross-section. Air leaving the fan passed through a large, box with walls like Venetian blinds, into the hall, from where it was sucked back again into the inlet.

Modern Wind Tunnels

A wind tunnel illustrative of modern practice is shown in Fig. 5. This is the No. 2, 11½ × 8½ feet closed-jet return-flow tunnel at the Royal Aircraft Establishment, Farnborough, in which a wind speed of over 200 m.p.h. can be attained.

The air is set in motion in a clockwise direction by the fan which can be seen in the top left-hand corner of the plan view; two 2000-horse-power motors are needed to drive it. After passing through vanes which remove any swirl imparted to the stream by the fan, the air flows along the long diverging channel. The increasing area of this channel is designed to cut down frictional resistance along the walls, by reducing the velocity, and also to allow any disturbances in the stream to settle out.

At the end of the channel a set of curved vanes, or 'cascade', deflects the airstream through a right angle, and a second cascade then brings it round so that it is now flowing in an opposite direction to its original one. To reach the working section it first passes through a honeycomb and some wire gauzes, after which there is a sudden contraction. This contraction cone is essential in a wind tunnel, as it helps to reduce the turbulence of the flow and thus produces a smooth uniform stream past the model. From the working section the air returns back to the fan through a gradually widening duct which includes two cascades.

One important question which presents itself immediately when dealing with wind tunnel tests is just how far the results obtained on a model are applicable to the full-sized body. The answer to this was supplied by Professor Osborne Reynolds, with his analysis of dynamic similarity for the flow of any fluid.

He defined a quantity which is now termed the Reynolds number, $\rho Vl/\mu$, where ρ is the density, V is the velocity, l is the representative length of the body (e.g. the diameter of a cylinder), and μ is the viscosity of the fluid. If this number is constant for two different conditions, e.g. for the model test and for the full-size test, then the flows are identical.

In the usual wind tunnel, which works at atmospheric pressure, the density and viscosity are the same as full-size, hence it is the product of velocity and length which determines the similarity, or otherwise, of the tests. Suppose the full-size aircraft travels at 200 m.p.h. and we wish to test a 1/10-scale model of it in a wind tunnel. Then for exact comparison the velocity of the airstream past the model must be 2000 m.p.h. This high speed is impractical, so that we have to test at much lower values of the Reynolds Number than those obtained by actual aircraft. From experience covering a large number of tests, it has been found possible to extrapolate from results obtained at moderate values of Reynolds Number up to full-scale values, but in many cases it was obvious that this method at its best was only approximate, while at its worst it was completely misleading.

An ingenious solution to the problem of obtaining full-scale Reynolds Number in a wind tunnel was proposed by Munk in America. The density of air depends on the pressure, while the viscosity is independent of it, at constant temperature; hence if the whole tunnel is enclosed in a pressure-tight shell, and air is pumped in so that the internal pressure is increased, the term ρ will increase but μ will stay constant. Consequently, at a pressure of twenty-five atmospheres the Reynolds Number of the tests in such a tunnel will approach full-scale values.

Fig. 6 illustrates a Compressed Air, or Variable Density Wind Tunnel, one of which is used in the United States and the other at the National Physical Laboratory. Both

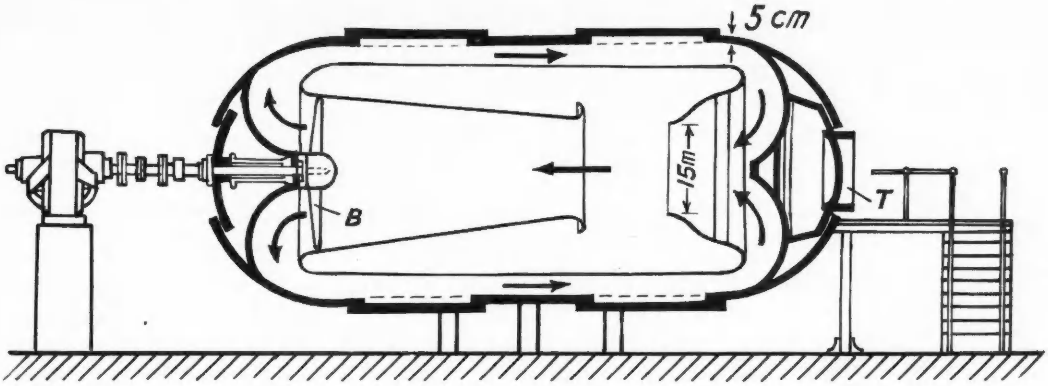


FIG. 6.—Diagram of a Compressed Air Tunnel. The outer shell must be capable of resisting the internal pressure of 25 atmospheres. Because of this pressurisation the balance which weighs the forces on the model must be fully automatic, with remote recording, and the model attitude must be controllable from outside the tunnel. Owing to their complexity, only two of these tunnels are in operation, one at the N.P.L., and the other in the U.S.A.

are of the annular return flow open-jet type.* The dimensions of the one at the National Physical Laboratory are: working jet, 6 feet in diameter; outer shell 18 feet in diameter; made from plate 2½ inches thick. A 500-horse-power motor is needed to produce a stream at 90 feet per second through the working section.

The method of operation of a C.A.T., the term by which the Compressed Air Tunnel has become known, is to mount the model on the balance, then hermetically seal the tunnel, after which a compressor brings the internal pressure to the desired value. The test is then carried out, with the balance recording automatically (since it is inside the pressurised tunnel), and automatic gear keeping the pressure constant.

Compressibility Effect

When the airstream velocity, or the motion of a body through still air, exceeds half the velocity of sound, the density changes of the air consequent upon any pressure changes become important, and the problems encountered are manifold and extremely unamenable to theoretical treatment (see DISCOVERY, "Problems of High-Speed Flight", July, 1945, Vol. 6, No. 7, pp. 212–16). The criterion for the dynamic similarity of tests under these conditions is the *Mach Number*, which is defined as the ratio of the velocity of flow to the velocity of sound under the same conditions of pressure and density.

In order to get an atmospheric airstream at high Mach Numbers an enormous amount of power is called for, and as a means of reducing this the method opposite to that of the C.A.T. is adopted. By reducing the pressure of the air, its density is reduced, and consequently it takes much less power to move this lighter air round the passages of the tunnel.

* All the previous tunnels mentioned have had 'closed jets', i.e., the working section where the model is mounted is enclosed by the tunnel walls. It has been found advantageous in some cases however to have an 'open-jet' working section, in which the airstream leaps across from a nozzle past the model into a collector cone.

The High Speed Tunnel at the Royal Aircraft Establishment, Farnborough (Fig. 1) indicates the complexity of modern aëronautical research. Construction is somewhat similar to the C.A.T., in that there is an outer airtight shell, but the range of pressure is from one-sixth of an atmosphere up to four atmospheres. When operating at the lowest pressure the 4000-horse-power motors driving a 16 feet diameter fan produce an airstream with 0·8 the speed of sound—equivalent to 600 m.p.h.—in a working section 10 feet × 8 feet. Because of the heat generated by the friction of the air as it streams along the tunnel walls, the whole tunnel has a continuous jacket wound round it through which brine at a temperature of −5° C. is constantly circulating.

Experimental Methods

We have already seen that the points needing examination are forces and pressure distribution on the model, and the disturbance to the flow caused by the body's presence. To investigate the forces, the model is attached by means of struts or wires to a balance. In the majority of cases this consists basically of a number of steel-yards, so arranged as to measure the components in different directions. Interference to the airstream by the struts must be kept to an absolute minimum.

The complexity of these balances arises from the fact that even the simpler ones are capable of measuring three quantities—lift, drag and pitching moment—simultaneously, without the reading on one arm being affected by the change in the weight on another. It is easy to imagine the problems involved in designing and building a balance dealing with six components simultaneously in which the weights are added or removed automatically until a balance point is reached, and their actual values recorded on indicator dials in a remote control room. Yet such balances are in use with the latest types of tunnels described above.

Examination of the pressure is a comparatively simple matter, using manometers; it merely involves leading a

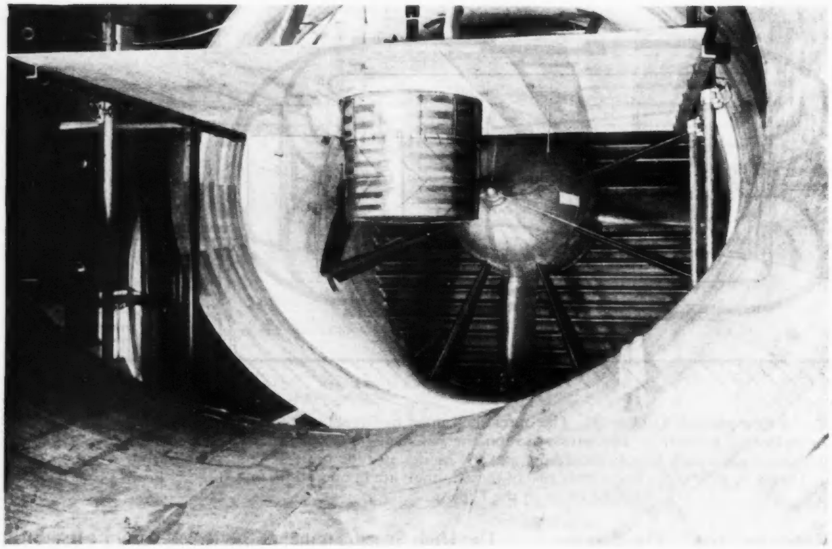


FIG. 7.—Tests for the pressure distribution around a 1/40th-scale model of a gas-holder being carried out in a wind tunnel.

tube from a hole at the appropriate point on the surface of the body to one arm of a glass U-tube containing fluid, and reading the pressure difference against atmosphere in inches of the fluid. Where a complete pressure distribution is to be taken, a number of holes at a suitable distance from each other are made in the surface, and the connecting tubes brought through the interior of the model to a multi-tube manometer. This consists of a bank of glass tubes connected to a common reservoir of fluid. The rising and falling columns of liquid in the tubes then indicates the pressure distribution.

Visual investigation of the airflow over the model is usually carried out by attaching tiny tufts or streamers of wool to wire rods projecting from the body's surface. When the stream is flowing smoothly past, these wool tufts point steadily downstream, but where any disturbance is occurring they start fluttering and oscillating. A good example of this method is seen as the angle of incidence of a wing is increased. Up to around 15° the streamers lie along the upper wing surface, but as soon as stalling starts, the breakaway of the air flow is indicated by tufts near the trailing edge starting to oscillate, until the stage of complete stalling is reached, when the tufts over the rear half of the wing are actually pointing forward towards the leading edge.

A more elaborate visual method is to generate smoke filaments, either from a comb of tubes upstream of the model, or from small holes on the model surface itself, and follow the path of these filaments as they pass over the model. Much useful information as to what is happening very close to the surface itself is obtained in this manner.

The experiments undertaken in wind tunnels fall into two distinct groups. They can either be fundamental ones designed to advance the theoretical basis of aerodynamics; or *ad hoc* experiments, such as tests of new aircraft while they are at an early stage in their design conception and development, and the solution of problems encountered by existing aircraft.

An example of the former can be seen in the development of a theory for the correct profile which a wing section should have in order to produce desired lift, drag and pitching moment characteristics. The original aerofoil sections were developed largely by empirical means and from the data obtained on these sections in the wind tunnel tests, a basic aerofoil theory was verified. This theory in turn was used to develop new sections, whose predicted performance was confirmed by routine wind-tunnel experiments. From this type of fundamental work the aircraft designer is enabled to assess which section will fulfil the specification of a particular aircraft, and to base his design on a reasonably accurate estimate of the forces and moments involved.

While theory will give an answer on the individual parts such as wings, tails, fuselages and engine nacelles it cannot cope entirely with the many unknown factors involved when these items are all assembled into one airframe, and here again we depend on the wind tunnel. Once the main dimensions and outlines of an aircraft have been decided on, a model of the proposed design will be made and extensively tested in a wind tunnel (Some

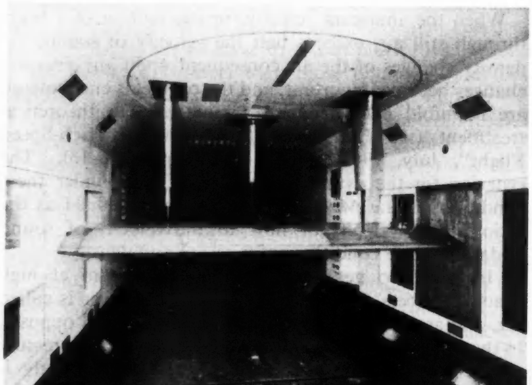


FIG. 8—Wing model being tested in No. 2 tunnel at the Royal Aircraft Establishment. The struts attaching the model to the balance in the roof can be seen: the large streamlined columns attached to the roof are shields for the struts, so that their drag is not added to that of the model.

firms have their own tunnels, but more usually the tests will be carried out at a Government establishment, such as the National Physical Laboratory or the Royal Aircraft Establishment, where more elaborate equipment is available.) It will probably be found from these that changes are needed to produce, for example, more stability, less drag or lower landing speed and not until a satisfactory model is obtained should the detailed design of the new aircraft go ahead.

The function of a wind tunnel is by no means at an end after a prototype aeroplane is actually built and flying, because quite a number of problems will occur in flight which were not manifested on the relatively small model. Typical cases, though many could be quoted, might be the opening in flight of the doors covering the undercarriage, due to some local peak suction, or an uneven flow of air at an intake to an engine or cabin ventilation.

The investigation of these would most likely be carried out by building a fairly large-scale model of that particular portion of the wing including the undercarriage, or air intake, and taking pressure distributions all round the troublesome areas. Visual means would probably be used also to help trace any peculiarities of flow. It might then be found that a comparatively simple solution, such as the addition of a fairing, would lead to satisfactory performance.

The wind tunnel can often be usefully employed on more prosaic duties than aeronautical research, as Fig. 7 shows. The model in this case is a 1/40-scale gas-holder, complete with spiral guide-rails, around which the pressure distribution was investigated. From the plottings round the circumference at various planes, and over the crown of the model, it was possible to get an accurate estimate of the forces and moments which might be expected to occur on a full-scale gas-holder at various wind-speeds. It thus gave a basis for deciding on the shape, number of segments, position of guide rails, etc., of gas-holders for various capacities.

Many queries as to the value, or otherwise of the streamlining of railway trains were answered by Johansen, using the N.P.L. tunnel in 1936.

Further tests were made to find the reductions of air resistance obtainable by rounding the front of the engine smoke-box covering the tender and gaps between adjoining coaches, fairing the trailing end of the last coach, smoothing the bodies, and enclosing the undercarriages. It was found that with fast trains of conventional design the air resistance is up to half the total train resistance at speeds over 80 m.p.h. Up to 70% of this air force can be saved by streamlining, with consequent benefit to running economy.

Interest in air resistance has become so general, that today no description of a high-performance motor car is considered complete unless it contains figures from wind tunnel tests to prove that the particular body design has been selected to give the least drag.

At present, the need for large high-speed wind tunnels is greater than ever, because relatively to the supersonic region, we are in the same position as the early investigators were in Eiffel's and Stanton's day with respect to the low-speed problems of flight. The fact that we are on the threshold of these great speeds only forty-four years after the first flight is sufficient proof, if such were needed, that the wind tunnel is an indispensable tool in the hands of the aeronautical scientist.

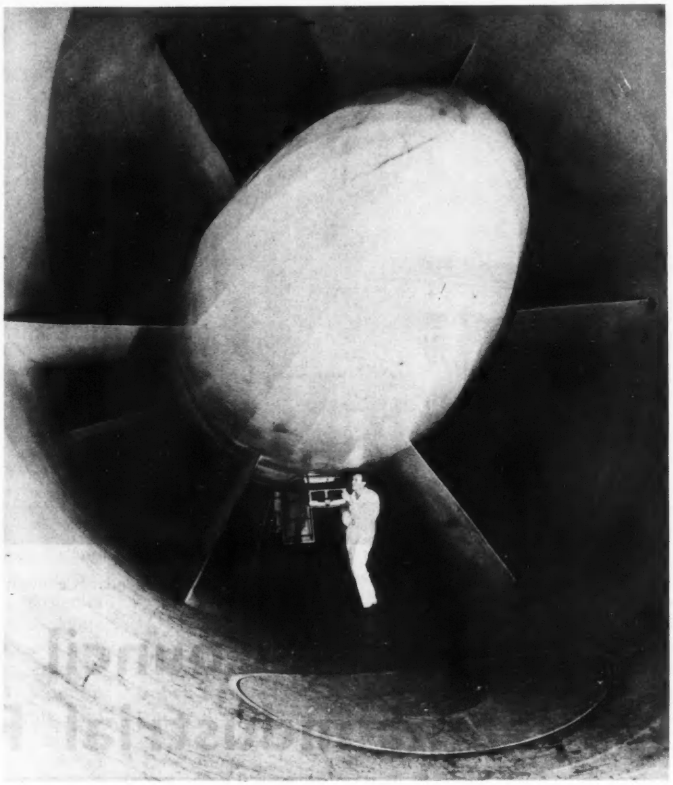
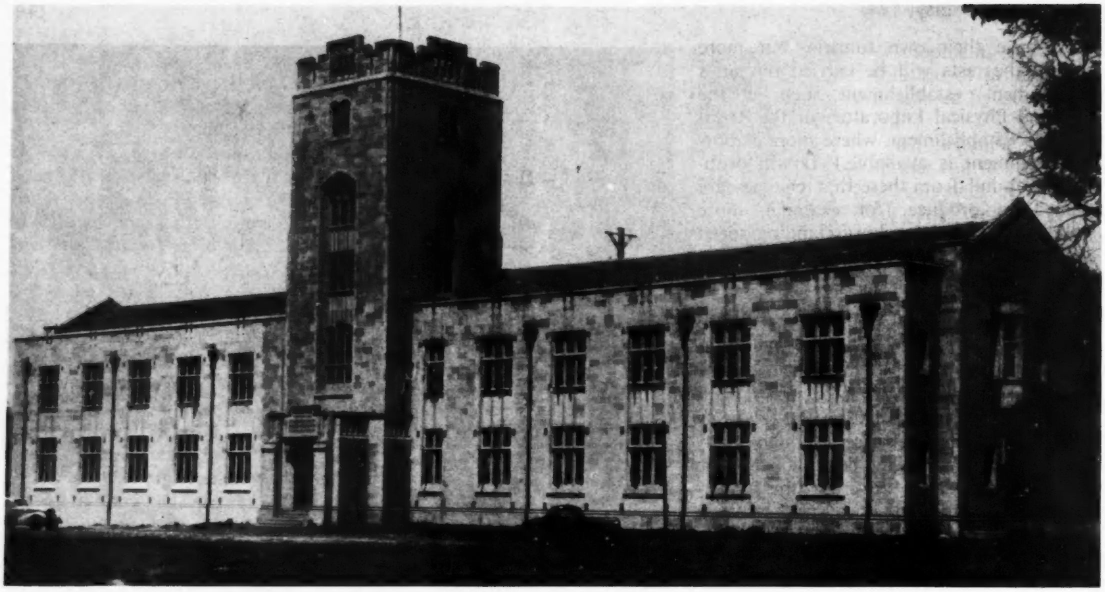


FIG. 9.—Looking upstream at the fan assembly of the Southern California Co-operative tunnel. This tunnel has two fans in tandem to absorb the 12,000 h.p. of the driving motors. The last row of vanes which can be seen in this photograph are the fixed blades which remove any swirl from the airstream.



The C.S.I.R.'s National Standards Laboratory, Sydney.

Australia's Council for Scientific and Industrial Research

The Germans demonstrated conclusively in World War I the vital importance of science in industry. The demonstration taught the rest of the world a lesson, and action to rectify the serious lack of science in industry was taken in many countries. By 1916 Britain had set up the Department of Scientific and Industrial Research, and the same year the Americans established their National Research Council. Soon after the war, the Australians followed suit.

Just as the organisation of Britain's Department of Scientific and Industrial Research reflects the economic balance between our different industries, so the Council for Scientific and Industrial Research set-up was necessarily related to the economic pattern of Australia. Australia's major industry then was farming, and for about the first twelve years of its existence the work of C.S.I.R. was mostly concerned with problems affecting the agricultural and pastoral industries. (Here is one very obvious difference between the organisation of research in Britain and Australia; agricultural research does not come under the D.S.I.R., but under the Agricultural Research Council.) It was the recognition that the farmer had the greatest claim upon the State resources in regard to scientific assistance that led to this policy; it was felt that by and large the individual farmer could rarely afford to employ a scientist, and even if he could do so, the scientist would not be very profitably employed; agricultural scientists would clearly not have been used to the best communal advantage if they were scattered about the country to a large extent duplicating work on *ad hoc* problems.

But in 1937 the Commonwealth Government decided to extend the activities of C.S.I.R. to cover secondary industries. This action paid rich dividends during the war; in particular, it enabled Australian industries to meet demands for certain wartime supplies and substitutes which would otherwise have been beyond their reach.

There are fifteen divisions within the C.S.I.R. These are as follows: *Plant Industry; Economic Entomology; Animal Health and Production; Biochemistry and General Nutrition; Soils; Forest Products; Food Preservation and Transport; Fisheries; Metrology; Physics;* and *Electrotechnology* (the last three divisions make up the National Standards Laboratory at Sydney); *Radiophysics; Aeronautics; Industrial Chemistry;* and *Wool Technology.*

The last-named is the latest Division to be set up. A Research Trust Fund, to support both textile research and biological research, is being raised by means of a levy of two shillings on every bale of wool clip produced by the industry, the Government contributing an equivalent sum of money.

One of the youngest Divisions is the Division of Radiophysics. It came into being as part of the plans made to meet the possibility of Australasia being cut off from Britain in event of war, plans which included a project for manufacturing radar equipment in Australia. Probably the Division's most successful single achievement was the

design and construction of a light-weight radar set for the Royal Australian Air Force for air-raid warning purposes. This set was urgently required following a series of devastating raids on Darwin, and the first equipment was built at very great speed, actually in five and a half days. Large numbers of sets of this type performed outstandingly well in various parts of the Pacific theatre. This set proved rugged and reliable in service and was easy to erect and maintain. It was moreover considerably lighter than similar equipment in use overseas at the time. All these factors made it of particular value for use under the special conditions of warfare existing in the Pacific, and it came into widespread use both by the Australian and United States Forces in this theatre.

Radar represents one of the most modern techniques, and in that respect it is strongly contrasted to agriculture. Turning for a moment to C.S.I.R. investigations dealing with peculiarly Australian problems of agriculture, the Plant Industry Division, which has central laboratories and experimental houses at Canberra, 600 acres for field experiments at Dickson, just outside Canberra, and several out-stations, solved many important wartime problems. It organised seed production so that supplies could be made available to farmers who had formerly relied on large amounts of imported seeds, and this was by no means a simple task, as experience in other countries, including Britain, has shown. Before 1939, Australia spent a great deal of money on imports of drugs. Wartime necessity forced self-sufficiency in a number of these drugs upon her, and it proved possible to produce eight vital drugs from plants grown in Australia. The opium poppy came under cultivation on quite a large scale, and its alkaloids were extracted. Two other medicinal alkaloids, atropine and hyoscine, were obtained from a native shrub (*Duboisia*) and here Australia was not only able to meet her own needs but came into the position of being able to export a surplus to Britain. It is even suggested that the whole world might obtain its supplies of hyoscine from this wartime source.

Weeds and Insect Pests

Australia has her quota of serious weeds, most of them alien plants. Her scientists have had some notable successes with biological control, in particular with prickly pear, thus opening up to farming millions of acres rendered useless by that weed. One of the promising insects which is now under test because it vigorously attacks St. John's wort is seen in the photograph on p. 146. Weed eradication has grown in importance as the mobilisation of Australia's army left the farms short of labour so that the weeds got somewhat out of control during the war period (see DISCOVERY, September 1946, pp. 260-1).

Biggest insect problem with which the Economic Entomology Division has to grapple is that of the sheep blowfly, which may cause in a bad year about £4 million worth of damage. DDT has been tested against the blowfly and found to kill the adult fly, but not the larva; periodical spraying is therefore necessary. Termites are very troublesome in Australia, causing damage not only to wooden structures but even to the lead sheathing of telephone cables. The termite nests have proved a serious menace on aerodromes in north Australia—the mounds are easily flattened but they are built up again to a height of 6 to 8 inches overnight. C.S.I.R. scientists found that powdered white arsenic was the most effective insecticide, and although DDT and Gammexane do a good job they are expensive compared with arsenic.

Among the most interesting work done by the Animal Health Division is the breeding of stock animals suited to Australian conditions. The Division has successfully cross-bred British breeds of cattle with Zebu cattle. The latter, which is typical of India and other tropical countries and which has as distinctive features a humped neck and a long, pendulous dewlap, is not disturbed by heat and is completely resistant to the ticks which upset British cattle. Crosses that are 'half' Zebu or 'quarter' Zebu can stand Australian conditions better than British cattle, though they generally harbour some ticks, their susceptibility to ticks depending upon whether they have inherited the Zebu or British-type coat. It is estimated that if Zebu crosses were generally used in the cattle country of the north the extra beef that could be obtained would be worth £250,000 a year. Sheep breeding is also being studied very intensively. A big research effort has been devoted to diseases of sheep. One of these, known as black disease, was costing £1 million a year, but C.S.I.R. research workers have perfected a vaccine that protects sheep against the species of bacteria causing this disease.

Research on Sheep and Soils

One particular pest that caused the Australian farmer much trouble is a blowfly which 'strikes' (lays its eggs) in the crutch of sheep. The early stages of the C.S.I.R. work on this problem were concerned with collecting facts about the fly responsible for the 'strike', and the factors that made sheep susceptible to 'strike'. A surgical operation called, after the layman, Mr. J. H. W. Mules, who first suggested it, the Mules operation, has been perfected, and this gives virtual control of 'crutch strike'. Controlled experiments recently carried out with over 7000 sheep showed that the length of tail is an important factor here; there was less 'strike' with a long tail than with a short one, the percentage of 'strike' in lambs that were docked when blowflies were very active being only 4·3% for medium-long tails, as against 21% for short tails and 7·5% for medium-length tails.

The Division of Biochemistry and General Nutrition has devoted much attention to the nutrition of farm animals. For example, the Division's scientists showed that cobalt deficiency could cause serious disease in sheep. The so-called 'coast disease', which affects an area of some 2000 square miles of high rainfall country in South Australia alone, was found to be due to such a deficiency. The major symptoms of the disease disappear when a very small amount of cobalt is administered, but with the suppression of cobalt deficiency an effect due to lack of copper made itself apparent. The dual deficiency has now been successfully remedied. Copper affects the character of the wool; a wool that should be crimped may become straight when the diet is deficient in copper; correction of this deficiency may increase the value of the clip from a single sheep by as much as three shillings. The nutritional physiology of sheep is now being intensively studied, with the object of finding the best diet for these animals

Research at C.S.I.R.

1. *Dried leaf of* Duboisia, *a native tree, is being ground in a* Wyley *mill to a fine powder ready for chemical assay. This leaf has been found to contain considerable quantities of the alkaloids hyoscine and atropine.*

2. *Inoculum of* Ophiobolus graminis, *the organism responsible for the 'take-all' disease of wheat being added to 5-gallon drums of soil one month after sowing of the wheat at the Division of Plant Industry.*

3. *Agglutination tests at the Division of Animal Health enable the progress of a bacterial disease to be followed and the effectiveness of control measures to be assessed.*

4. *The Division of Biochemistry and General Nutrition has perfected calorimeters by means of which the energy requirements of sheep may be determined. From these results a sound and secure basis for the computation of the quantity of each of a wide variety of fodders necessary to support sheep has been derived. This knowledge is essential for the formulation of long-range policies for drought feeding and relief.*

5. *Since 1927 the Division of Soils has continuously conducted soil surveys in all parts of Australia and to date detailed surveys cover 1.600,000 acres and reconnaissance surveys another*

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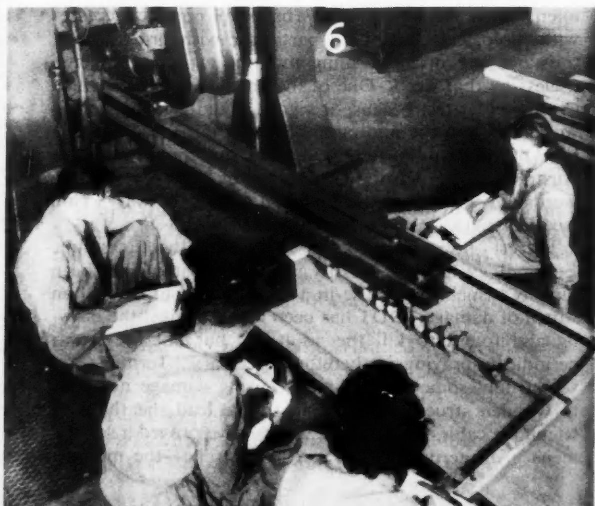

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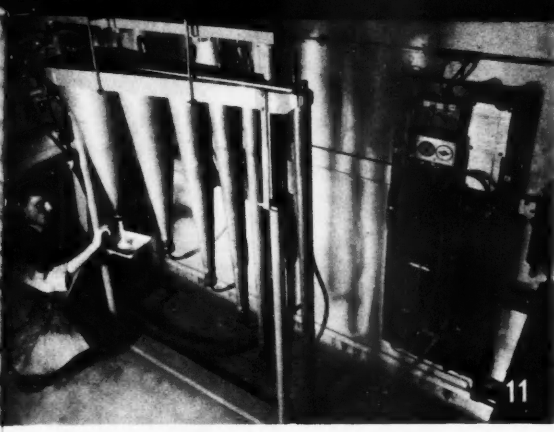

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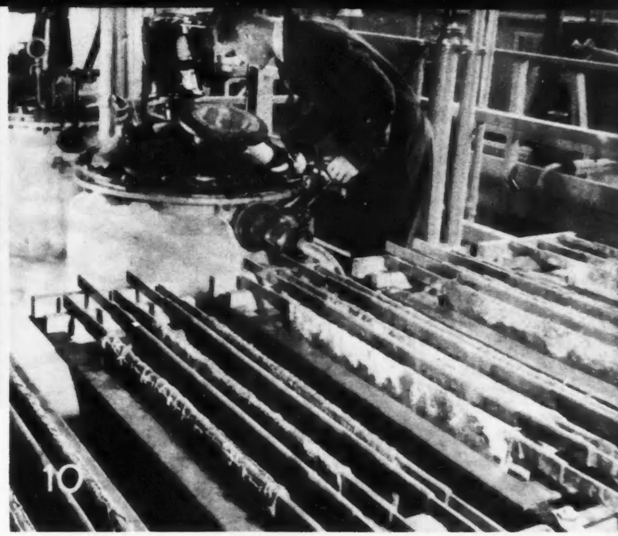

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2,000,000 acres. Any soundly based policy of land utilisation and subdivision must depend on the results of such surveys. The basis for the definition of any soil type is the soil profile usually made to a depth of six feet.

6. *A test on flooring boards in progress in the Timber Mechanics Section of the Division of Forest Products. Detailed information on the physical properties of Australian timber species is essential in determining the most suitable wood for any specific use.*

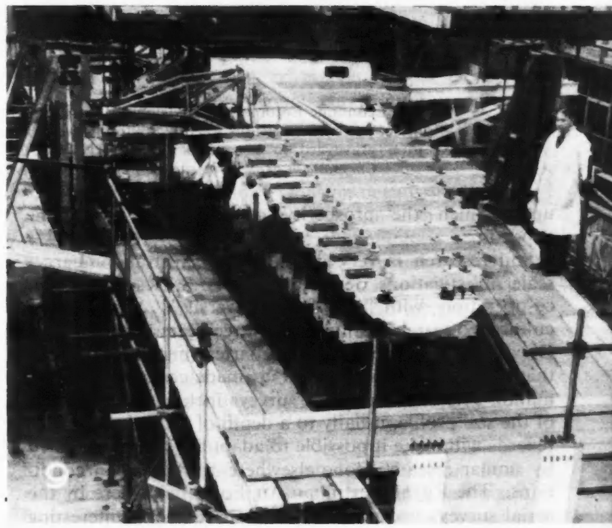
7. *Torsion test on plywood cylinder at the Division of Forest Products.*

8. *Hob Measuring Machine at the Division of Metrology. This equipment is available for the measurement of gears and hobs, or of other devices involving accurate angular division.*

9. *A complete wing of the Australian built Mosquito aircraft is shown undergoing a repeated load test with loads applied cyclically by a hydraulic loading system.*

10. *Pilot plant for the production of chromic anhydride from chromite ore. In the foreground are the electrolytic cells for the oxidation of chromic sulphate to chromic acid. Chromium compounds are required for the paint, tanning, and electroplating industries.*

11. *Haultain Infrasizer used in mineragraphic work for sizing finely-ground ore. The sample is placed in the smallest tube and compressed air is passed through the control board at the right hand side of the picture.*



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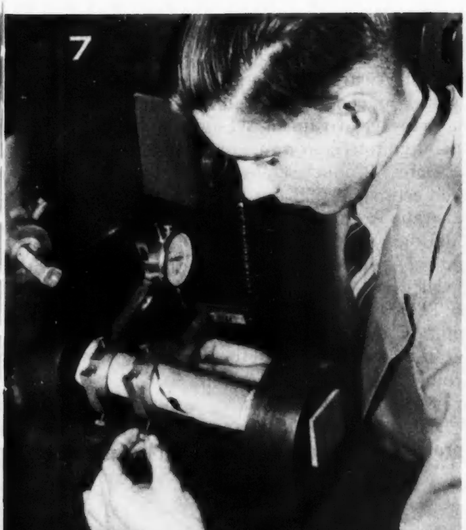

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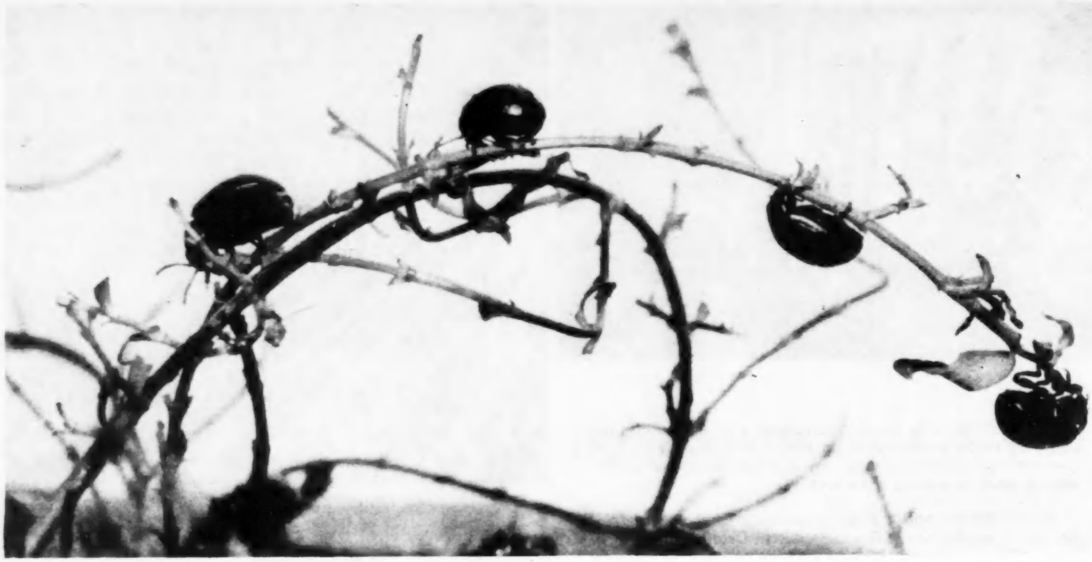


The Economic Entomology Division has done a great deal of work on the biological control of weeds and insect pests. One serious weed is St. John's wort, which has spread a long way from its original planting in a graveyard to cover vast areas of New South Wales and Victoria. Leaf-eating beetles such as *Chrysomela gemellata*, shown above, have given effective control of the weed in several areas.

upon which the prosperity of so many Australians depends.

Soil research is very important to Australia. Large-scale investigations were started by C.S.I.R. in 1927, in co-operation with Adelaide University's Waite Agricultural Research Institute, and three years later the Soils Division was set up with headquarters in the grounds of that institute. Soil surveys so far made cover about three million acres. The detailed surveys include the recording of the soil profile, usually to a depth of six feet, and these records will make it possible to adapt the results obtained by similar research done elsewhere to Australian conditions. The Royal Australian Air Force helps here by the aerial surveys it carries out. One particularly interesting piece of work was the survey made of the bed of Lake Albert, at the mouth of the Murray River. The object of the survey was to discover whether the soil of the lake bed was worth reclaiming. It proved to be unsuitable, and thus for a modest expenditure much money was saved because what would have been an expensive but unjustifiable project was dropped. Irrigation and erosion problems have also been receiving the attention of the Division's scientists. Valuable strains of nitrogen-fixing bacteria from the root nodules of such plants as subterranean clover and lucerne have been isolated and made available in large quantities to the State Services that distribute bacterial cultures to farmers.

The Forest Products Division has tremendous scope as Australia possesses a great variety of timbers. When the Division was established in 1928 Australian timbers were so badly seasoned that it was hard to persuade even local people to use them. Thanks to the researches and educational activities of the Division the standard of seasoning has much improved, so that today Australian wood is highly prized for its excellent properties. The shortage of long-fibred softwoods which make good paper led to the close study of eucalyptus wood. It was found that such timber could be converted into satisfactory paper, and this led directly to the setting up of three large paper mills employing thousands of workers and turning out materials worth well over £1 million a year. These mills, which supplied much-needed cellulose pulp for explosives during the war, are now being extended.

Investigations into wood-preservation problems have lengthened the life of electric supply and telephone poles, the annual saving on replacements so effected being estimated at over £500,000. The Division's studies of fungi that attack timber paid handsome dividends when in the recent war the Army moved into tropical areas, and the knowledge of preservative treatments helped to minimise losses due to equipment being ruined by fungi.

The needs of Australian aircraft manufacture led to extensive work on veneers and glueing, and a plywood industry has now grown up in Western Australia, using karri, the giant gum tree, as a raw material and the 'know how' of the Forest Products Division.

It has been estimated that less than 20% of the timber felled in Australia is ultimately used, the rest being wasted as low-grade logs, sawdust, shavings and so on. Taking into account the useless and misshapen trees that are not felled, the efficiency of utilisation is probably no more than 10%. To reduce the waste the Division is studying milling methods, the prospects of being able to convert sawdust into useful products, and the possibility of making plywood from species of trees as yet untouched.

The preservation of meat, fruit, eggs and fish provide the Food Preservation and Transport Division with plenty of problems. Wastage in plums, apples, pears and

oranges has been reduced as a result of scientific studies, while research on the ripening of bananas has helped materially in the development of a banana industry in Western Australia. Australian meat exports now suffer almost negligible losses, scientific slaughtering, cooling and storage of chilled beef, for instance, ensuring perfect transport though the voyage may last as long as sixty days. By 1939 the annual export of chilled beef had accordingly risen to 29,000 tons, valued at £1,000,000. The Division is now interested in the problems connected with the 'quick freezing' of fruits and vegetables, not only from the point of view of refrigeration technique but also because it will be necessary for farmers to grow the most suitable varieties if 'quick freezing' is to achieve the best results.

The Fisheries Division is doing a great deal of survey work, using aeroplanes as well as research vessels and fishing boats for the purpose. Aerial scouting has proved that it can contribute to the efficiency of fishing fleets, and the technique is now being developed. During the war the Division's work made it possible to produce large quantities of agar-agar, that valuable material in which Japan held a virtual monopoly before 1939, from native seaweeds. Before the war Australia used to import 85,000 gallons of cod-liver oil a year; now there is an important industry producing shark-liver oil and vitamin-A concentrates. The Division has been making important surveys of the distribution of pelagic fish such as tuna, pilchard, mackerel and sprat, and the results will undoubtedly bring commercial benefits. Another field of work in which the Division is keenly interested is the development of the oyster, crayfish, crab and scallop industries.

Experimental furfural distillation plant in the Industrial Chemistry Division.

The Metrology Division had some important war jobs to tackle. For instance the Directorate of Tools and Gauges gave the Division the task of investigating methods of producing slip gauges, and this problem, which involved an immense amount of very accurate work, was solved with great success, the demands of munition factories for these gauges being met. It sponsored the manufacture of pitch-measuring machines, micrometers and workshop projectors, too, and special measuring equipment not available from abroad was designed and manufactured by the Division.

The Physics Division met similar needs in respect of temperature-measuring instruments used in munition factories. On the low-temperature side the Division solved several problems that arose in drying blood plasma. A telephotometer used in connexion with camouflage work was designed and constructed by the Division, which also tested all optical glass manufactured in Australia, and supervised the manufacture of optical equipment such as naval gunsight telescopes, and mirrors for searchlights and heliographs. It was the centre of research and development for aids to night vision for the three Services. A special form of goggle was developed and manufactured for the Army and Navy, and this eliminated the danger of 'eclipse blindness', a form of permanent damage to the retina caused by concentrated sunlight among aircraft spotters.

In the Electrotechnology Division degaussing work was done for the Navy, and the Division also advised the Services on the design of electrical equipment capable of withstanding the rigours of tropical climates.

The Aeronautics Division has done invaluable work for the Australian Air Force, the Australian aircraft industry and the Department of Civil Aviation, and its activities are likely to increase with the post-war expansion of aviation in Australia. The Division is also playing a large part in the rocket developments now taking place in Australia.

Problems connected with wool receive considerable attention in the Industrial Chemistry Division, both at the fellmongering stage and when it becomes a raw material from which the chemist can make better fibres or new chemical products. What the chemist can contribute is expressed in the words of G. Lightfoot in the popular account of C.S.I.R. activities entitled C.S.I.R.—1945: *He must shrinkproof it, mothproof it, creaseproof it, and shineproof it; he must give it a glossy or a dull surface at will; he must learn to dye it more attractively and cheaply; and he must regard it as a protein from which may be made more valuable products.* He must develop methods of recovering wool wax, and make chemicals and drugs from its many constituents, some of which still remain unidentified.

The Industrial Chemistry Division gives constant attention to the important problems that arise in connexion with the utilisation of Australian minerals. A process developed by the Division makes it possible to produce potash fertiliser from alunite, and a new patented process has been devised for recovering chromium compounds. The exploitation of lithium and beryllium minerals is now under active investigation. The development of an organic chemical industry in Australia is naturally resulting in the widening of scope of the Division's research activities.

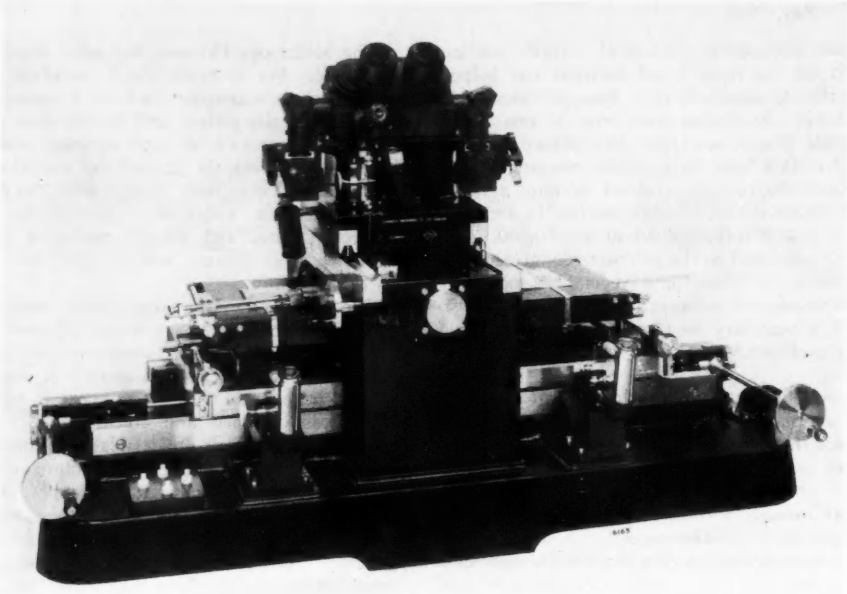


FIG. 1.—The Cambridge Stereo-Comparator.

The Physical Society's Exhibition

AT the Physical Society's Exhibition of scientific instruments which was held in Kensington during the week after Easter the visitor was treated to many astonishing demonstrations of salesmanship, showmanship and ingenuity. It is unfortunate, but perhaps inevitable, that so much emphasis is now placed on the first of these aspects in an exhibition which should primarily be used for introducing *new* instruments rather than for providing just another opportunity for firms to bring their names into the public eye. Too much of the limited space available was occupied by trade stands on which nothing original was shown.

For sheer showmanship there is no doubt that Professor J. T. Randall's centimetre-wave exhibit took first place, followed closely by a good demonstration of various supersonic effects by the G.E.C. Laboratories. Had either of these exhibits been set up in the market place of a country town the spectators would have been mesmerised and the demonstrators would certainly have been able to sell them large volumes of coloured-water panaceas—they might even have been able to revive ancient customs for the exorcism of devils and the disposal of witches! In Prof. Randall's exhibit a beam of ten-centimetre radio waves, generated by a magnetron and issuing from the mouth of a wave guide, was diffracted by a grating consisting of a few metal strips about two inches wide, and refracted by an enormous prism made of paraffin wax; the detector was a small neon bulb which glowed brightly in the beam. The polarisation of the beam was demonstrated by holding a pound note parallel and perpendicular to the longer side of the rectangular wave guide, the electric vector in the first case producing a sizzling spark from each end of the metal ribbon incorporated in the paper, while having no effect in the other direction. Several other 'magical' effects were also demonstrated with great verve. At the G.E.C. stand a beam of supersonic energy, generated by a quartz crystal oscillator immersed in a tank of oil, was focused by a concave metal mirror; when it was directed to the surface of the liquid it produced a jet of oil which would apparently pass through a sheet of distrene held just below the surface, owing to the high transparency of distrene for these vibrations. In the showmanship class we must also mention what might well be described as the apotheosis of the pin-table. This was a demonstration set up to illustrate the way in which a servo-mechanism can be used to solve equations and translate the results into mechanical motion. A small steel ball-bearing was dropped from a fixed position on to a flat steel anvil and bounced from there into an infallible receiving cup. The distance of the cup from the anvil could be varied and the servo-mechanism ensured that for every position of the cup the anvil assumed the inclination needed to produce the trajectory that would deposit the ball in the cup.

Ingenuity, although present in abundance, had to be sought for, and was frequently hidden in the recesses of the most inconspicuous-looking cabinets. Consider, for example, the Infra-Red Gas Analyser made by Sir Howard Grubb, Parsons & Co., of Newcastle. A tall steel cabinet

with a single pointer and scale is all that is visible from the outside. The purpose of the instrument is to provide a continuous estimation of, say, the carbon dioxide in flue gases. Its operation depends on the fact that most of the common gases have strong absorption bands in the infra-red region of the spectrum. If radiation is passed through an absorption tube filled with dry air free from carbon dioxide (such air has no infra-red absorption) and then enters a detecting cell containing an absorbing gas such as carbon dioxide, some of the radiation will be absorbed by this gas which will thereby be heated and develop an increased pressure. On passing air containing a small proportion of carbon dioxide into the absorption tube, some of the radiations which previously reached the detecting cell will be absorbed and the response will be reduced. Introduction of other gases into the absorption tube will have no effect on the detecting vessel unless these gases happen to absorb wavelengths common to carbon dioxide.

In the sketch (Fig. 3) the utilisation of this principle in the actual gas analyser is indicated. Radiation from the nichrome heaters *A A* passes through the absorption tubes *B B* and thence to absorbing vessels *C C* which are filled with the gas to be detected. A rotating shutter *S* allows light to pass intermittently, but simultaneously, through the tubes *B* and a heating effect is produced in each of the two chambers *C*. These receivers are partitioned off from one another by a thin metal diaphragm *D*, which, in combination with the closely adjacent insulated and perforated metal plate *E*, forms an electrical condenser. Any deformation of the thin diaphragm

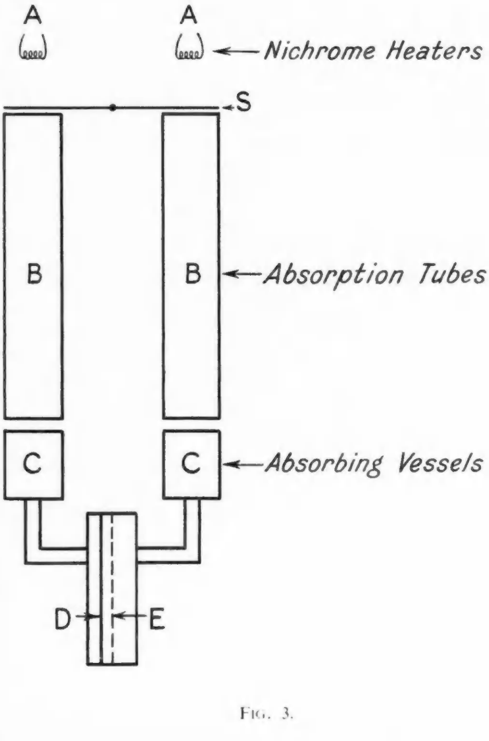


FIG. 3.

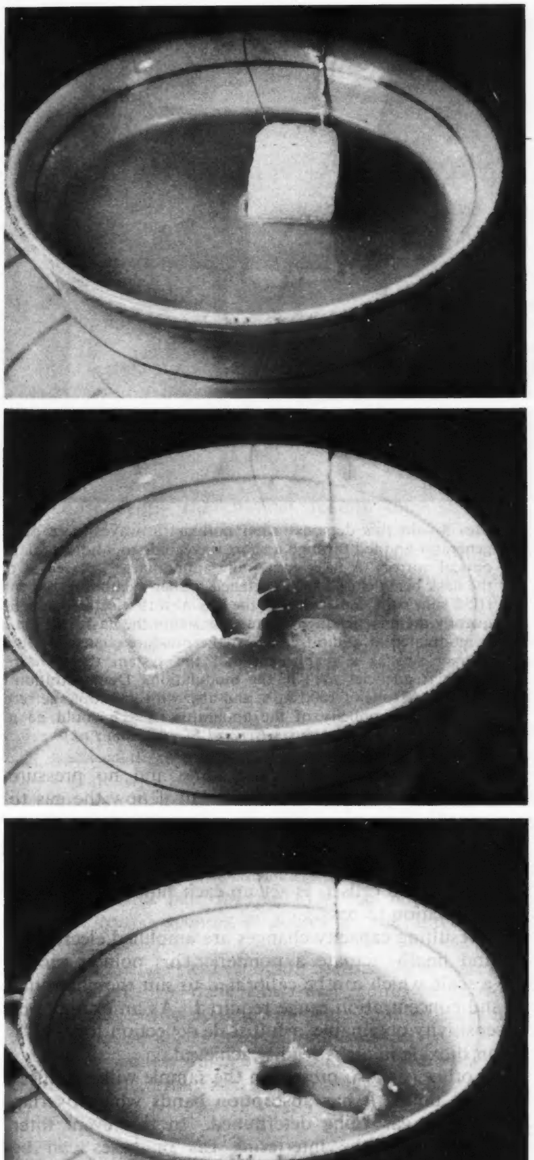


FIG. 2.—High-speed photographs of a lump of sugar falling into a cup of tea. Ilford H.P.3 Cut Film; lens aperture, F.22; two photoflash lamps at 5 ft; open shutter; flash synchronised by wire in the liquid, there being one wire in liquid, the other varying distances above liquid to get flash early or late. (*Photo by M. W. Keen, A.R.P.S.*)

resulting from a pressure difference between the two receiving chambers causes a variation of this capacity.

If no absorption occurs in the tubes *B* and the system is otherwise symmetrical, the heating effect in the two

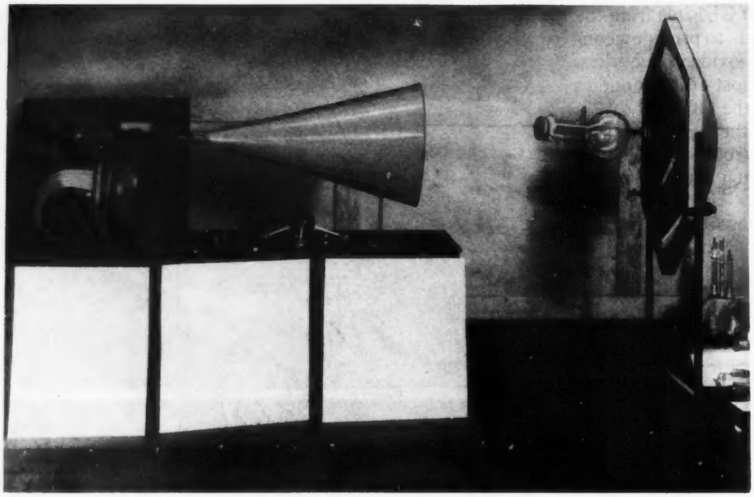


FIG. 4.—In this demonstration millimetric waves were produced by a magnetron generator and fed through a short waveguide to a horn radiator directed at a concave optical mirror. A flask containing ammonia was placed at the focus of the mirror, the flask being closed by a stretched rubber membrane. At the particular wavelength (12·5 mm.) the molecules of the gas absorb electro-magnetic radiation and consequently there is a change of pressure within the flask. As the output of the generator is modulated at audio-frequency, the pressure changes follow the modulation. The stopper acts as a diaphragm and the system therefore reproduces audibly the speech frequencies used in the modulation. Demonstration was made successfully with a pure tone of 1000 c.p.s. and also with gramophone records. In the latter case, despite the simplicity of the apparatus, speech could be understood. (*Courtesy, General Electric Co., Ltd.*)

receiving chambers will be the same and no pressure difference between them will arise; but if now the gas to be detected is introduced into one of the tubes *B* the energy balance is upset, since radiation is absorbed by the gas before it can reach *C*. Consequently a pressure difference between the two cells *C* is set up each time the shutter S allows radiation to pass.

The resulting capacity changes are amplified electronically and finally actuate a pointer. This pointer moves over a scale which can be calibrated to suit the particular gas and concentration range required. As an example of the sensitivity obtainable, a full scale deflection for 0·03% carbon dioxide in air is readily achieved.

Any other gas also present in the sample will not affect the result unless it has absorption bands which overlap those of the gas being determined. In this event filter tubes containing the interfering gas or gases can be included in the two optical paths, so that the radiations emerging from these tubes will contain wavelengths which can be absorbed by the gas to be detected but will contain very little radiation capable of being absorbed by the interfering gases in the sample, such radiations having been removed already.

The exhibition as a whole, as was the case last year, owed much to wartime developments. Commercial forms of some of the infra-red detectors described in the March issue of DISCOVERY were in evidence, and in this field several novel instruments were shown which had not been successful in fulfilling Service requirements but which will be of considerable value as research tools. Numerous variations of the high-speed flash tube for photography were to be found, including the Arditron type (*see* DISCOVERY, November 1946, pp. 325-7) which is by far the fastest. There was also a commercial example of the skiatron, or dark-trace cathode-ray tube, by Scophony; this was used by the Admiralty for radar displays (*see* DISCOVERY, December 1945, Fig. 14, p. 370), but obviously fulfils many other needs.

Aircraft instruments, with their special requirements of lightness and ability to function in various positions formed a specialised group of their own, and there was at least one new radio navigating system, called Condar.

The demands of atomic energy research were met by an unusual number of Geiger counters (*see* p. 130) and other devices for detecting radiations. It was interesting to note that the Electronics Group of the Government's Atomic Energy Establishment were exhibiting a number of such instruments, including various health-protecting devices which provide a continuous indication of the radiation density in laboratories in which radioactive materials are being handled.

Examples of fine workmanship in the classical instrument tradition were not hard to find. An outstanding case is the Cambridge Stereo-Comparator shown in Fig. 1 which was constructed for the Geographic Section of the War Office for measuring up aerial survey photographs.

Several computing engines, both mechanical and electrical, were to be seen. Some of these, while lacking the flexibility and the capacity of the giant engines such as ENIAC, employ similar principles and serve a very useful purpose in providing rapid solutions to the particular mathematical equations which they are designed to handle.

This brief account is far from exhaustive, and those interested should turn to the official exhibition catalogue, in which all the exhibits are described in detail. This catalogue was unfortunately delayed by the fuel cuts, and was not available in time for the exhibition. Let us hope the Physical has better luck next year.

A TRAIN EXHIBITION will start later this year on its journey round Britain to tell the public the facts about atomic energy and its industrial applications in a simple and attractive manner. The Atomic Energy Train will visit 55 principal towns and take a year to complete the course. At the various stopping places scientists will organise 'Atomic Weeks' which will include public discussions in order to focus attention on the significance of the industrial revolution which will be brought about by the harnessing of Atomic Energy. The Atomic Train Exhibition is being organised by the Atomic Scientists' Association with the co-operation of the Ministry of Supply.

Concluded from p. 128 .

The Eighteenth Century's Fuel Efficiency Expert

A. D. CUMMINGS, M.Sc., F.Inst. Fuel

IN *Essay* IV "Of Chimney Fireplaces" Rumford deals with the defects of open fire-places and their correction. In his day, a fire-place for room heating was usually a square opening in which stood an iron basket to contain the fire. The chimney was a straight shaft of similar dimensions to the fire-place opening. "The great fault of all open fire-places is that the throat of the chimney, or the lower part of it in the neighbourhood of the mantel and immediately over the fire, is too large. This opening has been left larger than it probably would have been made in order to give passage to the chimney sweeper, but I shall show how a passage may be contrived without leaving the throat of the chimney of such enormous dimensions as to swallow up all the warm air of the room." When Rumford came to England after experience with closed fireplaces in Bavaria and America he was astonished at the waste, inefficiency and nuisance of our open fires.*

Rumford's advice was sought by friends in London as to what they should do about chimneys that sent smoke into the room (they appear to have been only too common), and his fame spread. He speaks of having altered as many as 150 fire-places in two months. We get an odd picture of this court official from Munich hurrying from one great house to another, peering into chimneys, giving advice and setting bricklayers to work. He gives clear and explicit directions, with figures, how the work shall be carried out and intends his essay to be understood by all concerned.

In all cases the improvements he suggested resulted in a saving of fuel as well as curing the smoke nuisance. His alterations show that he had a thorough understanding of the use of open grates. His points may be summarised as follows:

1. The chimney is usually too wide, allowing too much interference with the straight rise of smoke and combustion products. Four inches is wide enough.
2. The fire-places should be as far forward as possible, not at the back of a recess.
3. It should be constructed of materials that reflect radiant heat.
4. Where the fire-place opening is too big (and this appears to have been the usual fault), it should be reduced by filling in the back and sides with bricks, reducing the width at the back and sloping away the sides so as to make an angle of 135 with the back (as in nearly all modern grates) instead of the right-angled recess common in his day. Where the opening is too shallow he sloped back the fire-place over the grate, as is again done in modern designs; this slope reflects a great deal of radiant heat, he notes.

In his tenth essay, Rumford deals with kitchen fire-places and the art of cooking, and has some sensible observations on the wastefulness of open fires, especially for roasting. Coming from Bavaria, where closed stoves were the rule for cooking and room heating, the open fires of the English kitchen struck him as extremely inefficient. They consisted of a front and bottom of wrought iron bars and a back of cast iron. This was set in a wide and deep chimney recess with a high mantel. In order to accommodate a number of pans it had to be very long, and the mantel had to be high to allow the cook to attend to the pans; the opening or throat was large and well above the burning fuel, consequently the chimney readily smoked. Every part seemed calculated for the express purpose of devouring fuel, he says, and in addition a smoke jack is often put in the chimney. The smoke jack was a mechanism to turn a roasting joint in front of the fire; it was turned by a vane set in the chimney rotated by the ascending hot air—and if the mechanism was poor it took a larger fire than the cooking required to turn the jack. Rumford recommended the following for improving cooking fire-places.

1. A separate fire-place for each utensil.
2. Each of these to have a separate ash-door closed by a plate with an air regulator in it and a separate flue to the chimney with a damper.
3. When the pans are larger than 8–10 inches in diameter it is necessary to provide a fuel door, since it is inconvenient to lift the heavy pans to add fresh fuel through the pan opening. The fuel door to consist of a round opening in a fire-clay tile, fitted with a plug.
4. Boilers and pans should be suspended in their fire-places by their rims and should be provided with covers to confine the heat, these to be double with an air space as insulation.
5. Larger boilers which are fixed in their settings should be oblong, broad and shallow.

He illustrates with examples of kitchens constructed according to his ideas, both in private houses and in institutions. These were all introduced in Munich, where closed fire-places were already an accepted thing, though scarcely so elaborate as Rumford's. He records one case where the cook began by entering his formal protest against the new design, but later expressed his entire satisfaction.

Except in his own house in London, and in the Foundling Hospital, Rumford's ideas do not seem to have been adopted here, and, although kitchen ranges improved, only fairly recently have closed or closeable stoves become common. Rumford, while admitting that he, too, likes the sight of the burning fuel, still hoped that the time would come when open fires would disappear altogether and be

* Very recently another American said, "Although the temperature rarely drops below freezing, the Briton burns nearly as much coal as the average man in America, where temperatures descend to thirty below. And he heats not a house but a few cubic feet of damp atmosphere in front of one or two hearths. You can see your breath even in his dining-room and parlour, and you let hot water stand in his tub for half an hour before you dare disrobe in his bathroom."

replaced with something less expensive and dirty and, rather curiously, "less injurious to my eyes".

One cannot help admiring the thoughtful lay-out of his cooking-ranges with their symmetrical array of large and small fire-holes, looking very like modern gas or electric ranges, and in spite of their complexity the comfort and convenience of the cook has been considered and all of several operations being carried on together would be controlled without much movement; although with wood as fuel the addition of fresh fuel at several points must have required a fair amount of time and attention. On the other hand, if only a simple operation is required, there is no waste of fuel as in a large range kept going for occasional needs.

He gives a design for a roaster to do away with the wasteful method of roasting in front of an open fire, but does not mention bread-baking, although this was an operation carried out in his institutions, and he gives an account of a measurement of the efficiency of the process (it works out at about 30%). He conserves the heat by having fresh batches of bread ready to follow each other.

In the same essay he gives a design for a continuous lime kiln, one of which was built in Dublin and another in Munich. The features of this kiln are a separate fire-place, working on a down-draught principle to save the loss of unburnt gases and to prevent the fuel from mixing with the lime, thus giving a better product.

In *Essay* XV "On the Use of Steam as a Vehicle for Transporting Heat from One Place to Another", he makes some sensible suggestions and has some modern ideas on the proper use of steam. In his day, many operations were carried out by direct firing which required only a low temperature, such as bleaching, dyeing and brewing. In this essay he says he found a dyer in Leeds who had acted on a suggestion Rumford gave in an earlier essay* to use steam for heating, and carried out all the dyeing processes this way instead of by fire. He told Rumford that the time to heat a 1800-gallon vat was half an hour with steam and one hour with direct fire. Rumford saw five advantages in using steam: boilers or vats could be of lighter construction if they did not have to stand fire; several could be heated by one boiler; the temperature would never exceed that of boiling water and injury to the substance heated would be avoided; food prepared in large quantities could be heated by steam, no stirring would be necessary and burning avoided; steam heat could be used for drying cotton and woollen goods.

He advises the conveyance of steam in pipes lagged with wood, powdered charcoal, wool or paper and glue. The pipes should be arranged to drain condensate back to the boiler and also suggests hot condensate from drying-rooms should be returned to the feed water tank and says escapes from safety valves should be used to heat feed water.

Tyndall, in his essay on Rumford (1892), says "There is no doubt that the present age has entered largely into the labours of Rumford. Many of the devices and conveniences now employed in our kitchens owe their origin to him." In the days of stringent economy now upon us we can still gain inspiration from his wholehearted zeal and even maybe find one or two hints in his admirably clear (if somewhat wordy) writings on the subject.

* *Essay* VII, "On The Propagation of Heat in Fluids".

READING LIST

Rumford. *Essays, Political, Economical and Philosophical*, 1796.

Rumford. *Life and Works*, published for the American Academy of Science, 1875.

Pasteur at a London Brewery

It is likely that the attention of visitors to the Pasteur Exhibition now on view at the Science Museum will have been so taken up with studying the brilliant, if sometimes slightly crude, style of presenting scientific facts which Paris's Palace of Discovery has developed that they will have missed seeing the microscope which is shown in the accompanying photograph. Yet this microscope is of no small interest, for it symbolises the importance of Pasteur's contribution to the improvement of brewing. Moreover, it is a reminder of Pasteur's visits to Britain, and of the readiness with which his novel ideas were adopted by this industry that has long been remarkable for the manner in which it supports scientific research, both pure and applied.

The official biography of Pasteur, written by Rene Vallery-Radot, gives some interesting facts about this symbolic instrument. In 1871 Pasteur crossed the Channel, because he "wished to see one of those great English breweries which produce in one year more than 100,000 hectolitres of beer. The great French savant was most courteously received by the managers of one of the most important breweries in London [Whitbread & Company], who offered to show him round the works where 250 men were employed. But Pasteur asked for a little of the barm of the porter which was flowing into a trough from the cask. He examined that yeast with a microscope, and soon recognised a noxious ferment which he drew on a piece of paper and showed to the bystanders, saying, 'This porter must leave much to be desired,' to the astonished managers, who had not expected this sudden criticism. Pasteur added that surely the defect must have been betrayed by a bad taste, perhaps already complained of by some customers. Thereupon the managers owned that that very morning some fresh yeast had had to be procured from another brewery. Pasteur asked to see the new yeast, and found it incomparably purer, but such was not the case with the barm of the other products then in fermentation—*ale* and *pale ale*.

"By degrees, samples of every kind of beer on the premises were brought to Pasteur and put under the microscope. He detected marked beginnings of disease in some, in others merely a trace, but a threatening one. The various foremen were sent for; this scientific visit seemed like a police inquiry. The owner of the brewery, who had been fetched, was obliged to register, one after another, these experimental demonstrations. It was only human to show a little surprise, perhaps a little impatience

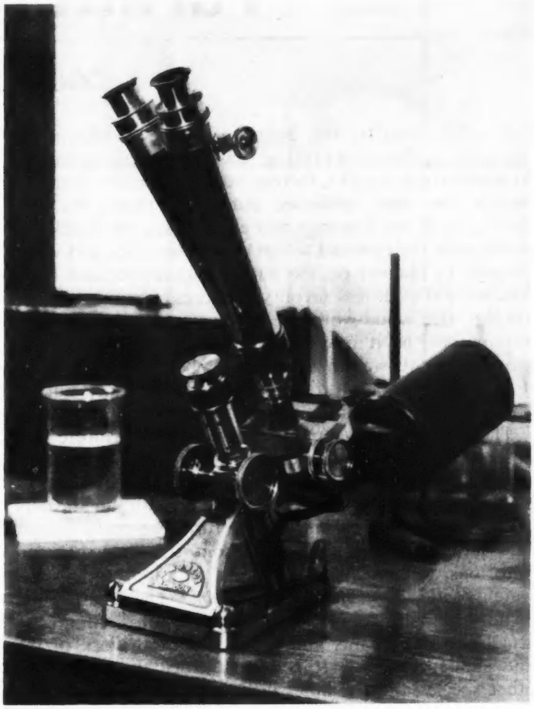
of wounded feeling. But it was impossible to mistake the authority of the French scientist's words: 'Every marked alteration in the quality of the beer coincides with the development of micro-organisms foreign to the nature of true beer yeast.' It would have been interesting to a psychologist to study in the expression of Pasteur's hearers those shades of curiosity, doubt and approbation, which ended in the thoroughly English conclusion that there was profit to be made out of this object lesson.

"Pasteur afterwards remembered with a smile the answers he received, rather vague at first, then clearer, and, finally—interest and confidence now obtained—the confession that there was in a corner of the brewery a quantity of spoilt beer, which had gone wrong only a fortnight after it was made, and was not drinkable. 'I examined it with a microscope,' said Pasteur, 'and could not at first detect any ferments of disease; but guessing that it might have become clear through a long rest, the ferments now inert having dropped to the bottom of the reservoirs, I examined the deposit at the bottom of the reservoirs. It was entirely composed of filaments of disease unmixed with the least globule of alcoholic yeast. The complementary fermentation of that beer had therefore been exclusively a morbid fermentation.' "

When Pasteur visited the same brewery again, a week later, he found that not only had a microscope been procured immediately, but the yeast of all the beer then being brewed had been changed. This is the microscope which Whitbread's have lent for the Pasteur Exhibition and which is illustrated here.

Pasteur's first contact with British scientists had dated back to 1856, when the Royal Society bestowed on him the Rumford Medal. The reward was made for his discoveries in crystallography. His researches which proved conclusively that fermentations are due to living bodies and not to Liebig's 'catalytic force' won him the Copley Medal in 1874.

Lister's antiseptic technique owed its inspiration to Pasteur's work. In a letter to Pasteur dated February 13, 1874, Lister wrote: *Allow me to take this opportunity to tender to you my most cordial thanks for having, by your brilliant researches, demonstrated to me the truth of the germ theory of putrefaction, and thus furnished me with the principle upon which alone the antiseptic system can be carried out.* One of the greatest champions of Pasteur's ideas was John Tyndall, who fought to a standstill the vivacious but unscientific English physician, Dr. Bastian (who had succeeded in creating a bitter prejudice both in America and Britain towards Pasteur's experiments), and showed the futility of the old belief in spontaneous generation. Dr. Bastian was a persistent critic, and challenged Pasteur with an experiment in which it appeared at first sight that urine could not be sterilised by heating. This apparent anomaly led Pasteur, with Chamberland and Joubert, to study the heat resistance of bacteria, and this further work led to the development of the autoclave and the Pasteur oven. The standard technique of putting culture tubes, cotton wool plugs, surgical instruments, etc., through a flame to sterilise them also dates from that final refutation of Dr. Bastian's claim. In 1881 Pasteur took part in the International Medical Congress held in London, lecturing on the theme of vaccination against anthrax and chicken cholera. (This lecture enjoyed the



This microscope is of great historical interest; it marked the introduction of microscopy into British brewing practice, and its procurement by Whitbread's arose directly from a visit by Pasteur to their brewery in 1871. (*Courtesy, Whitbread and Co., Ltd.*)

unusual distinction of being printed and circulated to every member of the House of Commons!)

In 1884 he visited Edinburgh on the occasion of the university's tercentenary. The high regard in which Pasteur was held by British brewers was evidenced in the fact that Mr. Younger, the Edinburgh brewer, reserved a special railway coach to take Pasteur and his friends to Edinburgh and made a donation of £500 to the university "in memory of M. Pasteur's visit to Edinburgh". (This gesture reminds one that a marble bust of Pasteur was commissioned by the founder of the Carlbserg Brewery and placed in the laboratory there.)

One of Pasteur's greatest triumphs was the judgment passed on his method of treating rabies by a Commission sent by the British Government. The members of this Commission were Sir James Paget, Dr. Lauder Brunton, Mr. Fleming, Sir Joseph Lister, Dr. Quain, Sir Henry Roscoe and Professor Burdon Sanderson. Of their verdict, Pasteur wrote: *During the long course of my scientific career, I have never experienced a happiness equal to that which I felt on reading this report.*

The catalogue of the Science Museum's Pasteur Exhibition remarks on the close connexions between Pasteur's work and that of British scientists, and points out that the work of Sir Alexander Fleming and Sir Howard Florey's team on penicillin brought to fruition Pasteur's belief in the doctrine of the antagonism of microbes.

Furniture Beetles

P. B. COLLINS, B.Sc., A.R.C.S.

THE prohibition by the Board of Trade of the use of sapwood in furniture-making, on account of its liability to wood-worm attacks, focuses attention on the furniture beetles, the least publicised but by no means the least damaging of our common household pests. While clothes moths take their annual toll of costly furs, flies and wasps descend in plagues on the hapless housewife, and cockroaches and even less savoury creatures swarm in many a kitchen, the wood-worm, secure inside our most prized antiques or, as it now transpires, our hard-won utility pieces, bores its way to and fro, only betraying itself when it emerges as an adult, ready to spread the attack but too late to be scotched on its own account.

The insects whose depredations in utility furniture have upset the Board of Trade are not the 'wood-worm' of the antique-dealers but the larvae of the 'powder-post' beetles of the genus *Lyctus*, while the antique-dealers' enemy is *Anobium punctatum*, the furniture beetle proper. This latter insect is itself often confused with the more notorious, but much less common or important, Death-watch beetle, *Xestobium rufovillosum*. The Death-watch is not normally found in furniture at all, confining its attacks to oak beams and other structural work of this and similar timbers. It is almost twice the size of the other species and the holes it makes are correspondingly larger.

The furniture beetle proper, *Anobium punctatum*, is "probably present in most houses, and by far the commonest cause of wormy furniture".* This is the insect, the results of whose larval activities are revealed in spring by the appearance of small piles of yellowish dust beneath the cherished heirloom sideboard, or by the sudden collapse of that old chair recently rescued from the oblivion of the damp cellar. (New furniture is not attacked by this species and in Sweden it is said that no attacks were found in houses less than 25 years old.)

The emergence of the adult beetles takes place at any time from late April until July, during which period they may sometimes be seen on the wing, but are more likely to be found crawling about on window frames or lying in a moribund state on the sills. These beetles are rather thick, about $\frac{1}{5}$ inch long, less than a third of that in width and dark brown in colour. Examined casually they look curiously blunt-ended, due to the head being bent forwards and downwards; this feature is useful in distinguishing *Anobium* from *Lyctus*.

Pairing between the beetles takes place soon after emergence and the fertilised females then search for a site on which to lay their eggs, "the chief factor governing the choice of site being the opportunity of wedging the egg firmly in a small hole or crevice", according to the leaflet on furniture beetles of the Forest Products Research Laboratory. Oily, greasy or highly polished surfaces are avoided, ideal sites being the rough-ended surfaces at the base of chair-legs and the narrow joints and cracks at the back of cheap furniture. Eggs are laid one or two at a time, hatching shortly into minute white grubs which make their way at once into the wood. Changing its skin in a few days, the *Anobium* larva acquires the characteristically thick and strongly developed fore-end, deep into which is set the head with small but powerful jaws. This grub is equipped internally with symbiotic yeasts, whose action on the cellulose eaten by the larva makes it available for the latter's digestion. Externally, the grub is equipped with dorsal spines by which it gets a purchase for locomotion in its burrow.

In this country the larval life is normally two years but it may be three or even more, especially in a very dry (e.g. centrally heated) house. The spring of its final year will find the full-grown grub making its way close to the surface of the wood, sometimes even breaking that surface to push out a pile of dust before making the pupal chamber. In this, metamorphosis occurs, first into a pupa and then, after a few weeks, into an adult, which gnaws its way to freedom. Like many wood-borers, the adult *Anobium* can penetrate thin layers of metal, such as the foil used to line tea-chests.

The Lyctids, of which a number of species now occur regularly in Britain, have a similar life history, which takes, however, only one year. These beetles are slightly shorter than *Anobium*, rather more narrow in proportion, with the head set in the same plane as the rest of the body, and varying in colour from almost black to dark chestnut-brown. Egg-laying is done by inserting the long, very slender ovipositor into the actual pores in the wood; the pores of coniferous timbers are too small and these are free from *Lyctus* attack.

Unprovided with symbiotic yeasts, the *Lyctus* larva, which resembles that of *Anobium* except for the absence of spines and a more distinct 'head', feeds on the actual contents of the cells, mainly starch, the presence of which in fair quantities is essential for its survival. It is for this reason that *Lyctus* attack is confined to sapwood.

Certain similarities and equally marked differences in the life-history and habits of the two types of beetle are now apparent. In general, *Anobium* attacks old furniture, and although it prefers sapwood, few woods normally used are free from the danger of a well-established colony in a neglected house; plywood, however, is at all times particularly susceptible to attack. In effect, the appearance of this beetle is almost certainly due to local neglect and cannot be blamed against the builder of the premises or the manufacturer of furniture or fittings. An exception is the case of newly introduced antique furniture. If this shows signs of adult *Anobium* emerging within a year, and probably within two years, it can safely be said that larvae were already in the wood at the time of its acquisition. The frequent occurrence of *Anobium* in plywood, so much used as a receptacle for stored goods, renders furniture that has been stored in company with it especially liable to attack.

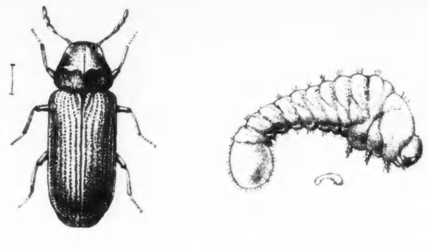
* FISHER, R. C. Furniture Beetles and other Wood-borers: *Annals of Applied Biology*, Vol. 29. London 1942. See also *Furniture Beetles*, pp. 26, British Museum (Natural History), 1946.

The householders whose new furniture suddenly appears riddled with the exit holes of *Lyctus* is on different ground, and this the makers of furniture and fittings, as well as the Board of Trade, have been forced to recognise. For *Lyctus* will have attacked the timber when it was still on the premises of timber-merchant, manufacturer or dealer. That this responsibility is now recognised is shown by the facts recently reported in *The Times* (January 21, 1947). Reference was there made to the number of firms now giving considerable time and attention to the repair and reconstruction of new utility furniture, returned by purchasers on the appearance of wood-worm attack. Most of the affected timber is stated to be the sapwood of imported American Oak. It has in fact long been considered in the furniture trade that "remedial measures may not even be worth while, replacement with sound wood being all that is practically possible".

Both groups of furniture beetles are truly cosmopolitan and a large amount of research into their prevention and control has been done in all parts of the world. In India, for example, where *Lyctus spp.* are known as "the Small Wood Ghoon", Army ordnance authorities have been at great pains to instruct those responsible for stores, which have suffered disastrously from attacks of these and other wood-boring beetles. In New Zealand records were made of the emergence of over 15,000 adults (of *Anobium*) from timbers in various parts of Auckland over a period of three years. German workers have established the fact that *Anobium* is more prevalent in coastal districts than inland, probably because of the higher relative humidity; this agrees with another New Zealand report that "at 22·5 C., the highest hatching rate is achieved at over 80% relative humidity". From Sweden comes the information that infestation (in roof timbers) is more severe under iron or tar-paper roofs than under tiles; houses with roofs of shingles are most commonly attacked. These and a host of other reports from Britain, the United States, Spain and South Africa give a picture of many scientists at work on these insects. Fumigation with prussic acid gas; heat treatment; pre-fabrication treatment by soaking raw materials in toxic chemicals, which may also be incorporated in the glues used for bonding plywood; soaking the feet of articles of furniture in turpentine or spirit, these and hundreds of other preventions and cures have been tried, suggested and more or less strongly recommended in all parts of the world. But in the end, seeing that "seldom if ever are timbers for indoor use treated in this country to withstand the attack by insects", it would appear that the individual householder must make himself responsible for keeping his home and its contents free from wood-worm.

To this end, a large number of proprietary remedies are on the market, and almost every dealer in antique furniture is ready to recommend his own particular fancy. How efficient that may be can perhaps be gathered from the case of a dealer in a west-country town, who claimed "definitely to exterminate the worm within one year". The specimens shown in his window in a test-tube of spirit, and labelled 'the worm', proved to be a species of common garden centipede!

Nor are the authorities much more helpful. Heat is recommended, but at the same time it is pointed out that much antique furniture is cracked, warped or otherwise



(*Left*)—The Common Furniture Beetle, *Anobium punctatum*. (*Right*)—Its larva.

ruined by prolonged 'baking'. Fumigation, which is in any case of doubtful efficacy, is beyond the means of the average householder and may prove nearly as dangerous to him as to the pest he is seeking to destroy; and the soaking of furniture in toxic chemicals is equally inconvenient. The chemicals most usually recommended are benzene in some form or other, various oils, and, more recently, pentachlorphenol. DDT has been tested but no specific preparation of it for this purpose seems to exist, although at least one proprietary wood-worm destroyer now claims to contain this modern panacea.

A good proprietary preparation of this type is probably the householder's best weapon, provided it is carefully used. His equipment should comprise a largish paint-brush, for covering large, rough, unpolished areas of wood; a very small one, for working into cracks and bad joints; and a syringe—either an old fountain-pen filler, or a hypodermic syringe. (The needles of the latter need to be broken off close to the base to enable it to be pressed close against the wood.)

The article under treatment is cleaned and all rough surfaces brushed over with liquid, which is worked into all cracks and joints. An uninfested article is then protected. If the article is already attacked, the syringe is used to inject liquid into every hole in turn, special attention being paid to fresh holes. A surprising demonstration of the ramifications of the burrows within the wood is usually obtained, when liquid injected at one place suddenly squirts out several feet away! If holes are then plugged with beeswax or plastic wood, so much the better, as new exit holes then become at once apparent. One authority recommends reinforcing decrepit but highly prized articles by injection with hot parchment-size!

The above treatment should be carried out in April or May, when the insects are most vulnerable, larvae being full-grown but close to the surface; and again in August when young grubs have not yet burrowed deeply into the wood. Repeated for at least two, preferably three consecutive seasons, this treatment should be successful; that repetition is essential is agreed by all authorities, one of whom sums up the situation thus: "There is no known substance which, in one application, can be relied upon to eradicate entirely the common furniture beetle from timber or furniture."* In the face of which, perhaps, many an owner who finds his house the centre of an attack, will prefer the more simple advice of Dean Swift, that "a kettle of scalding water injected infallibly cures the timber affected".

* KELSEY, SPILLER and DENNE "Biology of *Anobium punctatum*"; Progress Report. *N.Z. Journal Sci. Tech.*, Vol. 27. Wellington, N.Z., 1945.

The Bookshelf

Miracle Drug. The Inner History of Penicillin. By David Masters (Eyre & Spottiswoode, London, 1946, pp. 191, illustrated, 10*s.* 6*d.*).

THIS book tells an exciting and instructive story, its thesis of the purely British character of the discovery of penicillin being well documented. The development of Fleming's original observation by the Oxford team directed by Florey to the point where clinical trials were successfully carried out and the revolutionary character of this new antibiotic established receives due recognition. This important phase in the history of penicillin will always be associated with the names of Florey, Chain, Abraham and Heatley.

The need for additional material took Florey and Heatley with samples of *Penicillium notatum* to America in mid-1941. They explained, cajoled and instructed wherever they could arouse interest so that, by the time they left, all their information to date had been passed on to the Americans. Additional material was slow in coming, and back in England they turned to Kemball Bishop. This old-established chemical firm was operating, under licence from an American company, the process for manufacturing citric acid from molasses by means of *Aspergillus niger*. They were able to turn their microbiological experience to account in preparing a metabolite containing penicillin in larger volumes than had been possible at Oxford. The other great chemical and drug houses of the country were not far behind in beginning work. The method of Kemball Bishop adapted from their *A. niger* work was to culture the mould on trays. I.C.I. proceeded along the lines of developing a continuous process in trays by replacing the medium under the mould from time to time. The other workers went ahead developing the standard methods of the bacteriological laboratory and so achieved penicillin production by the 'milk bottle' process. It was in 1942 that the Ministry of Supply entered the field, to direct and assist the work, and ensure that information could be pooled and priority given where necessary.

The degree of co-operation effected was surprising. Information became freely available between British workers and enthusiasm reigned. The contribution of the United States soon became formidable. It was found there that corn steep, a by-product in the manufacture of starch and cornflour from maize, gave greatly increased yields of penicillin when added to the culture medium.

At this point, the author hints that difficulties of a non-scientific character began to trouble the British producer. We were, of course, having a hard time in the war and materials were scarce. The Ministry of Supply were able to make available accommodation, of a kind, for the expanding work. By their aid Glaxo were enabled to expand from improvised accommodation in a milk factory in rural Aylesbury to the top floor of a rubber factory in Watford, and finally—the height of favourable surroundings!—in a fish- and bone-meal works in the East End of London. They were amazingly successful in developing the surface-culture method of production, in which thousands of bottles are used, each containing a small amount of medium for the growth of the mould. Other producers also had enthusiastic teams.

In 1943 the Ministry of Supply encouraged the planning of large 'bottle' plants for production by surface culture, except in the case of I.C.I. which pinned its hopes on the continuous tray method. In the United States, on the other hand, work on 'deep culture', whereby the mould was being grown in large volumes of liquid aerated in tanks, was gathering momentum. This process was rapidly to render all other methods obsolete. Its development was facilitated by the existence at Peoria of a U.S. Department of Agriculture Research Station where Gastrock and Porges had earlier pioneered the technique in the production of gluconic acid. The book is reticent here about the delay in transfer of this knowledge to Great Britain and its application to the problem of reaching large-scale production. There was undoubtedly interest here, and inquiries were made about this American development. The official attitude to this interest seemed to be:

Thou shalt not kill; yet needst not strive
Officiously to keep alive.

In 1944 it became clear that deep culture was going ahead. The drug house of Pfizer in America was well away, and Commercial Solvents, with the consulting chemical engineers, E. B. Badger & Co., had built a large plant though they had no previous experience. In Britain some members of the Therapeutic Research Corporation reacted to this American advance and planned a large pilot plant, for 'deep culture' working. They might have had this working in 1944, but the Ministry of Supply thought it better to send to America and buy the plans of the Commercial Solvents plant. It now appeared that what we freely gave was coming back with strings attached. Delays were considerable, and it was not until 1946 that the agency-operated Ministry of Supply factory at Speke, pictured in this book, came into operation. In view of the difficulties this factory was to experience, it was as well that Sir Henry Jephcott had the enterprise to see Pfizer, Merck and Squibb and arrange for the building of the Glaxo factory at Barnard Castle.

The study of the inner history of penicillin makes one feel uneasy about the role played by the Ministry of Supply. Were their hopes falsely raised by the trace of antibiotic activity obtained synthetically in 1944? Were they outsmarted by the Americans? They must have slumbered somewhat for the *American* Heyden Chemical Corporation to slip in and obtain permission to build a factory in Scotland!

The innermost history of penicillin will probably never be told and Mr. Masters's book deals only with the outer fringe of the 'inside story'. It is certain, however, that we have by no means reaped what we sowed. It would be unfair not to recognise the zest and skill with which the Americans developed what we brought. They possessed, and *utilised*, besides time and industrial potential, facilities scarcely brought into the picture in Britain; for instance, they exploited the skill of mycologists, geneticists and chemical engineers, who together probably played the decisive part in the industrial developments. Where we produced mutants of the penicillin mould in tens, they produced and tested thirty thousand. Where Sanders in his Oxford laboratory started off with a solvent-extraction process which he built himself out of glass tubing, the American chemical companies reached the stage when they could export completely engineered plants that would work continuously. This book should be an encouragement to us to treasure our discoveries and to have more confidence in our own abilities in the future. M. A. N. Y.

Penicillin; its Properties, Uses, and Preparations. (Pharmaceutical Press, London, 1946; pp. 200; 10*s.* 6*d.*).

ALTHOUGH this book is written for those, such as practitioners and pharmacists, who have actually to handle penicillin, it contains much information useful to those with wider interests in the subject. The authors have wisely recognised that this particular aspect of penicillin cannot be properly understood without at least a working knowledge of all the properties of penicillin. Consequently, although the emphasis is naturally on the dispensing and clinical use of preparations containing penicillin, good, though short, accounts are included of the history of penicillin, of its large-scale manufacture, and of its chemical nature and properties. For those who wish to delve more deeply, there is a well-chosen bibliography of more than three hundred references to original literature. The final chapter and appendices are devoted to legal considerations relating to the manufacture, dispensing and sale of penicillin. Attention is rightly directed to certain legal anomalies, many of which arose because the provisions of the Therapeutic Substances Act are really not applicable to penicillin. Antibiotics other than penicillin are not discussed.

The book is well planned and clearly written. For the pharmacist for whom it is intended it will prove invaluable, and if brought up to date from time to time it should remain a standard book. The many others who have a scientific or technical interest in penicillin will find it a useful book of reference, but it is not a book for the general lay reader.

TREVOR I. WILLIAMS.

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Letters to the Editor

SIR—I was very surprised to read such an essentially reactionary article as that by Dr. Darlington.

Dr. Darlington may be horrified that Soviet scientists should query the validity of the laws of genetics; but that does not justify him in attacking Soviet scientists on what are indeed political grounds. The political spleen and the vindictive anti-Communist and anti-Soviet spite of his article have blinded his objectivity and led him into some very unscientific arguments against Lysenko.

But the worst feature is that you can print such an article at a time when the need for atom control and the interests of scientific progress demand more friendly relations between the peoples of our country and the U.S.S.R. and the U.S.A. and the utmost collaboration between scientists. Your January issue contained an article about Soviet incentives that was distinctly biased by the all-too-prevalent Russo-phobia that is bedevilling international relations; but at least you compensated for it with a trite journalistic piece by a Russian on the same subject.

I hope that you will make amends for Dr. Darlington's diatribe with an article, preferably by a Soviet scientist, that presents a critique of Dr. Darlington's speciality. Goodness knows the geneticists require it, if only because of the reactionary conclusions that are drawn from their work by eugenists and every other political outlook that would frustrate any radical changes in our social and economic life.—Yours, etc.,

H. C. CREIGHTON

SIR—It was with the greatest astonishment and regret that I read the article "A Revolution in Soviet Science", by C. D. Darlington in February's DISCOVERY: astonishment to find a political article in this journal, and regret that it should be of this particular variety.

I do not speak of the main body of the article in question. It is clear that Darlington does not approve of Lysenko, and attacks him in every possible way, from direct accusations of ignorance to subtle insinuations of theft of ideas. It is an example of scientific polemic, which, while bordering on the libellous, is quite in accordance with the traditions of controversy in science. It is not my intention to defend Lysenko, who should be capable of doing so himself. Either he is introducing something radically new into genetics, or else he is a charlatan who should be exposed as quickly as possible. (There is always the possibility that he may be both!) In either case, the controversy must be resolved, not by argument, but by the method of science itself, i.e. by research in genetics. One is reminded by this article of the occasion when Newlands first presented his "Law of Octaves" to the Chemical Society. A learned gentleman got up and inquired of Newlands whether he had discovered any laws by putting the elements, not into order of atomic weights, but in alphabetical order.

I am constrained to protest against the bad taste of the end of the article. A disagreement in genetics should not be used as an excuse for dirty political insinuations. Neither science nor peace are served when responsible scientists permit themselves to be associated with those irresponsible politicians who cry, "Let us use our atomic bombs on Russian totalitarianism now rather than later."

General statements made about the 'liquidation' of scientists and the suppression of scientific controversy, with no evidence to support them, will give satisfaction only to those who, in their heart of hearts, hate science and all that it has given and will give to humanity.—Yours, etc., M. HAMILTON, M.B.

SIR—I beg to take the strongest exception to Dr. C. D. Darlington's article, "A Revolution in Russian Science", which was published in your February issue. I do this, not on the grounds that he is attacking Academician Lysenko, but because, by the use of innuendo and assertion in place of any reasoned statement of fact, he has attempted to create a misleading impression of the position of genetics in particular, and by implication, the position of science in general in the Soviet Union.

He writes: "We see indeed the official overthrow of truth and reason and of the men who stood by them in one branch of science," (p. 43). This is preceded by a statement that: "The leading Russian geneticists (apart from those who have taken refuge outside Soviet-controlled countries) have been 'liquidated' in the course of this long political intrigue. These are no longer questions which can be argued about in Russia. They have been decided. All those who have been prepared to argue have been put away." (p. 43).

The evidence in the article for the latter statement rests on his enigmatic sentence: "But Asseyeva is no longer there to reply," (p. 43), and on an ambiguous construction on page 40, in which the death of Vavilov is associated with his replacement as President of the Lenin Academy, by Lysenko. I am unaware of the history of Asseyeva, but I note that, as co-author of Vavilov's obituary in *Nature*, Dr Darlington is only able to confess his ignorance of the exact circumstances of Vavilov's death.

His generalisation may be shown to be false by the provision of positive evidence to the contrary. Reference to the monograph of Hudsen and Richens shows that A. R. Zhebrak has been one of the leading protagonists of classical genetics in the arguments with the Lysenko school. According to Dr. Darlington, all such protagonists of 'truth and reason' have been 'liquidated' or 'put away'. It is strange, therefore, to find the same Zhebrak writing in *Science* of October 5, 1945 (p. 357) that: ". . . Academician Lysenko's criticism of genetics, based as it is on naive and purely speculative conclusions, despite the vigour of its assault is incapable of impeding the onward march of genetics in the U.S.S.R." (p. 358).

"The fact that Academician Lysenko is director of the Institute of Genetics of the Academy of Sciences does not mean that other schools of Soviet geneticists are in any way hampered in their work. It would be wrong to deny that Academician Lysenko was rewarded for his work in the field of practical scientific farming and not for his views or experiments on genetics. Furthermore, a number of our geneticists and plant breeders—some of whom have developed new varieties of the chief grain crops (Konstantinov, Lisitsin, Shekhurdin, Yuriev, the present writer and several others) and who have sharply criticised Academician Lysenko's views on genetics and selection—have also been decorated by the Soviet Government." (p. 358).

It seems strange that Dr. Darlington should see fit to ignore the evidence provided by such statements, which run counter to the general attack, that he makes upon the scientific milieu provided by the Soviet Government.

Professor N. P. Dubinin's articles in *Science*, Jan. 31, 1947 (p. 101), provides further evidence that Soviet scientists, even after being 'liquidated', are able apparently to carry on their work as before. His summary indicates that even throughout the war, the Soviet Government encouraged a large number of biologists to make advances on a number of fronts in the science of genetics, which, if we believe Dr. Darlington, is an officially proscribed science. I am aware that Professor N. P. Dubinin's article appeared after Dr. Darlington's article was finished, but I find it difficult to believe that he was unfamiliar with, at least, some of the work referred to by Professor N. P. Dubinin.

I can agree with him that the implications of the situation with which he deals "reach beyond the scope" of his review, and that "men of science everywhere will do well to ponder them". I trust that they will take more trouble than has Dr. Darlington, in ascertaining the facts. Having done this, they will, I am sure, draw their own conclusions, not only as to the state of Soviet science, but also, as to the political role that Dr. Darlington is playing. His article provides a notable addition to the general fog of misrepresentation, which the Soviet Union has constantly tried to overcome; and, instead of opening the door to an increased flow of mutually fruitful and constructive criticism, between this country and the Soviet Union, it can only make this more difficult. In particular, this article offers further opportunity for Academician Lysenko to identify the defence of his own views with the defence of the Soviet Union.

For these reasons, I believe that the publication by a journal of high repute, of Dr. Darlington's article in the form in which it appeared, represents a regrettable lowering of the standards of scientific journalism.—Yours, etc.,

J. W. LEGGE.

Far and Near

Night Sky in June

The Moon.—Full moon occurs on June 3d 19h 27m, U.T. and new moon on June 18d 21h 26m. The following conjunctions take place:

June				
2d 00h	Jupiter in conjunction with the moon.	Jupiter	0·02	N.
16d 08h	Mars ,,	Mars	0·7	N.
17d 10h	Venus ,,	Venus	1	S.
20d 14h	Mercury ,,	Mercury	4	S.
21d 11h	Saturn ,,	Saturn	4	S.
29d 01h	Jupiter ,,	Jupiter	0·3	S.

The Planets.—Mercury is an evening star, setting at 21h 43m, 22h and 21h 06m, at the beginning, middle and end of the month, respectively, and can be seen in the western sky for more than 1½ hours after sunset, brighter than a first magnitude star, until June 25 when the planet's magnitude is 1·2. Mercury reaches its greatest eastern elongation on June 17 and is stationary on June 30. Venus is a morning star, rising at 3h, 2h 44m and 2h 41m, at the beginning, middle and end of the month respectively, and can be seen as a conspicuous object of stellar magnitude −3·3, over 90 per cent of the disc appearing illuminated. Mars rises in the early morning hours, 1h 10m before sunrise on June 1 and 2h 10m before sunrise on June 30, and can be seen for a short period in the eastern sky. Jupiter is visible until the early morning hours, setting at 3h 06m, 2h 07m and 1h 05m, at the beginning, middle and end of the month, respectively. Notice the conjunction of the planet with the moon on June 2 and 29. Both of these phenomena will be interesting as Jupiter makes a close approach to the moon on each occasion. Saturn can be observed only in the early portion of the night, as the planet sets at 23h 39m on June 1 and at 21h 54m on June 30—in the latter case only about 1h 20m after sunset: at this time of the month it will not be well placed for observation. Summer solstice occurs on June 22d 06h, when the sun reaches his greatest northern declination, and after this the days commence to grow shorter.

On June 3 there will be a partial eclipse of the moon, partly visible at Greenwich. On June 3 the moon rises (in the latitude of Greenwich) at 17h 46m and enters the umbra at 18h 56m, leaving the umbra at 18h 34m, or 1h 33m before sunset. As only a small portion of the moon's disc will be darkened, the eclipse will not be very spectacular.

The long summer days combined with double summer time will render observations somewhat difficult during June, and probably few will find much opportunity to study the stars at this time of the year. The bright star Arcturus in the constellation of Bootes is worth noticing, and is easily found by prolonging the tail of the Great Bear and bending it slightly. This star, which is about 40 light-years from us, and has a diameter of about 20 million miles, has a velocity of 84 miles a second almost transverse to our line of sight, that is, it is neither approaching nor receding much from us (its velocity away from us is only 3 miles a second). Its luminosity is more than 100 times that of the sun.

14 'Exceptional' Civil Service Scientists

THE Barlow Committee which studied the position of scientists in the Civil Service drew attention of the failure of the Government Service to attract the outstanding scientists. The White Paper on the Scientific Civil Service (Cmd. 6679, 1945) provided for the creation of special posts above the Principal Scientific Officer level so that individual research workers of exceptional talent could be promoted and yet remain free of administrative duties. The following fourteen scientists have now been specially appointed to Senior Principal Scientific Officer grade under this scheme:

MR. J. W. BARNES (Ministry of Supply), DR. J. BRONOWSKI, (Ministry of Works), MR. H. L. COX (D.S.I.R.), DR. G. E. R. DEACON (Admiralty), MR. S. B. GATES (Ministry of Supply), DR. J. A. LOVERN (D.S.I.R.), MR. J. MORRIS (Ministry of Supply), MR. H. B. SQUIRE (Ministry of Supply), DR. W. S. STILES (D.S.I.R.), MR. BEN SYKES (Ministry of Supply), DR. A. H. TURING (D.S.I.R.), Dr. A. M. UTTLEY (Ministry of Supply), Dr. W. H. J. VERNON (D.S.I.R.) and DR. D. WILLIAMS (Ministry of Supply).

The quota of such special posts has been provisionally fixed at 2% of the total establishment of Scientific Officer Class posts. The fourteen appointments represent about a third of the number which the Treasury is prepared to authorise.

First British Radio-Controlled Projectile

THE first British pilotless, radio-controlled rocket missile, which has been under secret development for eighteen months, has now successfully completed a full range of flight trials. This new missile, designed and developed by the Research Division of the Fairey Aviation Company, was sponsored by the Directorate of Guided Projectiles, Ministry of Supply. It has been developed to the stage where a controller on the ground can exercise full flight control and pass the pilotless missile through a predetermined programme of aerial manœuvre. Using four 75-lb. thrust rockets, the maximum speed is far in excess of 500 m.p.h. Smaller rockets (of 40 lb. each) give a top speed of 350 m.p.h. The guided missile on trials, using standard 3-inch booster rockets for take-off, attained a speed of 267 m.p.h. only two seconds after firing.

The development story began during the closing stages of the war in the Pacific, when the Ministry of Supply recognised the need for a new type of weapon as a counter-measure to suicide-bomber tactics by Japanese pilots.

The missile was envisaged as incorporating a warhead which would explode on its target and infallibly blow itself to pieces. In the design offices the missile acquired the expressive code-name of 'Stooge'.

Conference on Radioactive Tracers

A CONFERENCE is being arranged on "Applications of Radioactive Tracer Elements in Physics Research and Industry", from 2 p.m. on Thursday, July 10 to noon on Saturday, July 12 in the Physics Department of Manchester University. Dr. J. D. Cockcroft, C.B.E., F.R.S., Prof. F. Paneth, F.R.S., and Mr. D. H. Wilkinson, will give the opening papers. The Conference will be open to anyone interested, without charge, but admission will be by ticket only. Further particulars may be obtained from the Conference Secretary, W. J. Meredith, Esq., F.Inst.P., Christie Hospital and Holt Radium Institute, Wilmslow Road, Manchester 20.

Schools get Surplus Radio Components

UNIVERSITIES, technical schools and other educational establishments have bought radio components to the value of £30,000 which have been made available by the Ministry of Supply from the Government surplus stores. This represents about one-sixteenth of the total of surplus radio components sold by the Government, a total which includes 23,000,000 fixed condensers, 800,000 variable condensers, 23,000,000 resistances and 1,000,000 valve holders. A proportion of the remaining surplus stocks will be sold; for instance, another 12,000,000 fixed condensers are being released. Such surplus stores as cannot be released without causing serious harm to the industry and which will deteriorate if kept in store too long are to be scrapped. This course will not be adopted for items that are in comparatively short supply.

The Oldest Chemical Society

THE claim (made in our February issue) that the Chemical Society is the oldest chemical society in existence is challenged in a letter from Dr. Henry Tod, F.R.S.E., who points out that the Edinburgh University Chemical Society very considerably antedates the Chemical Society, "having been founded by Joseph Black, in, as far as I can remember, 1785. This society, though largely an undergraduate one, has had an unbroken existence to this date, with a membership of from 150 to 300 according to circumstances, and it was unquestionably founded for the study of chemistry."

A New Ultra-Rapid Photographic Process

FOR some months reports have been circulating that Mr. E. H. Land, the American pioneer of polarising filters, had perfected a new technique for developing and printing photographs inside the camera, immediately after exposure, in less than one minute. Newspaper reports of a demonstration of this method dealt with the construction of the camera from which the final print could be withdrawn by hand shortly after the exposure had been made.

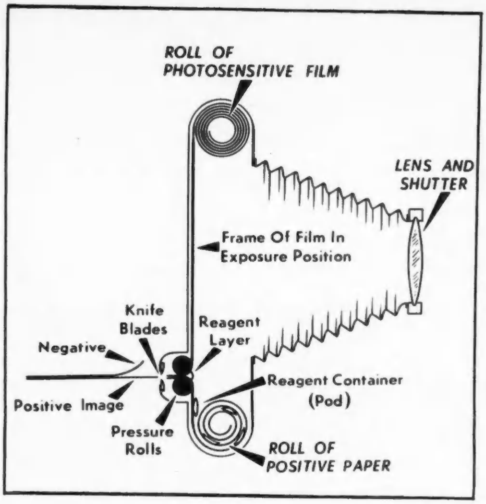


FIG. 1.—Sketch showing the operation of the new camera. FIG. 2.—Edwin H. Land, inventor of the camera.

Now that a full report has been received of Mr. Land's invention,* it is clear that it is even more interesting than is suggested by these descriptions, and that the printing technique involved may lead eventually to a revolution in the practice of photography, at least in certain fields.

It has always been obvious that the ideal method of photography would be one in which the settings of the camera were either automatic or immaterial, while the final positive print could be taken from the camera immediately, without the necessity for the use of liquids and without having to be washed or dried. Mr. Land has not concerned himself with the mechanical aspects of the equipment, except incidentally, but he has produced a method which goes very far along the road towards the instantaneous production of dry prints.

The problem of producing a print quickly in the camera is not fundamentally a mechanical one, as is often supposed, but rather a chemical one. In the ordinary photographic process, the negative is first developed to produce an image and then fixed to remove the remaining light-sensitive silver halide and render the negative transparent. It has been appreciated for some time that, by the use of suitable solutions, these two processes can be carried out in a total time of under fifteen seconds. But the negative still has to be printed in order to obtain a positive image, and this entails the introduction of another sheet of photo-sensitive material, with its associated exposing, developing and fixing operations. To carry out such a series of operations in the camera is undoubtedly mechanically difficult, and the use of liquids (particularly solutions of the type needed for such rapid action) is highly undesirable in portable equipment, especially as they would normally be required in considerable bulk to deal with every picture on a roll-film. Methods have been published for avoiding the use of spillable solutions by employing highly viscous concentrated chemicals or using rollers or pads of jelly impregnated with the solutions. None of these has been really successful so far, however.

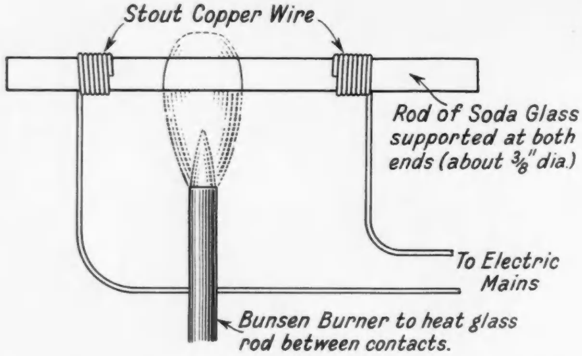
A variation of the ordinary negative-positive process just described is the 'reversal' process used for 16 mm. ciné films, colour films and some other materials. In this, the negative is not fixed but instead the image is dissolved away and the remaining silver halide blackened to form the positive. This process is obviously a fruitful one from which to start when trying to make 'instantaneous' prints in the camera, as it avoids a printing exposure and also at least one of the chemical baths normally required. It is, however, difficult to carry out rapidly in one stage.

The ingenious novelty in Mr. Land's invention is that he has devised what is fundamentally a reversal process but, instead of dissolving away the negative image, the negative and positive are developed simultaneously *but in two different layers which can afterwards be peeled apart*. In order to avoid the use of liquids, a viscous solution is used, which is held between these two layers and is absorbed by them, leaving both practically dry at the end. In other words, the positive print is not produced by the action of light but purely by a chemical reaction controlled by the negative as it develops.

In the equipment demonstrated by Mr. Land, which can produce a positive print in 50 seconds from the time of exposure, a normal negative roll-film is used. The lens, shutter, bellows and film holder are also normal, but in the position usually occupied by the take-up spool is a roll of paper (see Fig. 1). This has a specially prepared surface and attached to it, at intervals corresponding to the distance between one exposure and the next on the negative film, are a number of plastic pods containing the viscous processing solution. After each exposure, the film and paper are drawn off together face to face through a pair of pressure rollers on the back of the camera, which break the pod of solution and squeeze the two layers together with a layer of the solution between; the contents of the pod are designed to be sufficient for this purpose without leaving an appreciable residue. The sandwich can be cut off by means of a knife and, after about 50 seconds, the two layers are peeled apart, one having a perfect positive print on its surface (see Fig. 2). This dries almost immediately and needs no washing.

The liquid in the pods is a developer of an energetic type mixed with a fixing agent, the mixture being dissolved in a viscous liquid such as sodium carboxymethyl cellulose or hydroxyethyl cellulose. The high viscosity serves to bond the two sheets together, to prevent wetting the inside of the camera, to aid uniform spreading and yet to enable sufficient bulk to be present to contain the amount of material needed to complete the required reactions. The plastic also provides a protective colloid action which enables the point of precipitation of the positive image to be controlled. The developer-fixer attacks the negative material, developing an image and simultaneously dissolving away the unexposed silver halide. The solution of this silver salt then diffuses back through the developer layer until it meets the coating on the surface of the paper on the other side of the sandwich. The silver is then precipitated to form the positive image and the fixing chemical is released to start the cycle again. The colour of the positive image is controlled by the size of the particles of which it is made up. By the use of different reagents any colour from yellow, through brown, to blue-black can be obtained. The image is crisp, clear and not susceptible to fading or other deterioration but only one print can be obtained from each negative, and this has to be rephotographed if another copy is required. The exposure required for the

* *J. Optical Society of America*, 1947, Vol. 37, No. 2, pp. 61–77.



Sketch of apparatus mentioned below in "A Thermocouple Effect".

negative is normal (or slightly less than normal) but the limits of permissible error are narrower than normal, as with most reversal processes.

The idea of producing prints by chemical contact methods of this type is so novel that it is bound to have marked repercussions upon photographic technique in general. Whether it will eventually appeal to amateur and professional photographers depends upon many factors such as the quality of the results, their market price, permanence and so on, but where a result is required quickly, as in press photography, race finishes, document copying in the office and scientific recording, there can be no question of the fundamental importance of this technique. In addition, it is likely to give considerable information on certain aspects of the theory of photographic processing, and possibly of the nature of the latent image in the silver halide grains.

A Thermocouple Effect

We have received from Mr. William Thain a letter explaining the phenomena described in our note "Science Masters' Annual Meeting" (February issue, p. 61). Mr. Thain writes as follows: "The experiment with the sensitive galvanometer almost certainly shows the existence of a metal—glass thermocouple. I have repeated the experiment and have found that by heating in the same way each time the galvanometer was deflected in the same direction. The uncertainty in the initial deflection appears to be a matter of which junction is heated more strongly. I could not reproduce the reversal of current on removing the flame, but it is probably a peculiarity of the original apparatus allowing the exposed junction (which would usually be the hot one during heating) to cool more rapidly than the one inside the glass tube and so reverse the thermocouple.

"The second effect, viz. the conductivity of glass at high temperatures, is fairly well known. Glass has a fairly high negative coefficient of resistance which is well shown by an experiment demonstrated to me by Dr. G. D. West, Military College of Science. Two contacts are made on a glass rod by winding on it two short lengths of copper wire a few inches apart (see diagram). If these contacts are connected to the mains no current flows. If, however, the glass rod is heated to about red heat by a Bunsen burner between the contacts, the rod will conduct and maintain its temperature with the flame removed. The current is usually sufficient to increase the temperature and since the temperature coefficient of resistance is negative the increasing current almost invariably melts the rod.

"In the experiment shown at the meeting, of course, the current is limited by the resistance of the indicating lamp and will be too small to heat the glass rod."

New Director of Naval Science

Mr. F. Brundrett has been appointed Chief of the Royal Naval Scientific Service in succession to Sir Charles Wright, who has retired. Mr. Brundrett has been in the scientific service at the Admiralty since 1919, and during the recent war was largely responsible for the mobilisation of scientists and scientific workers in the Government service and the setting up of an inter-service organisation for valve development.

World Power Conference

The World Power Conference is holding a Fuel Economy Conference at the Hague on September 2–9. Among the ten British speakers will be Professor J. D. Cockroft, director of the Didcot Atomic Energy Research Establishment, who will talk on "The Possibility of Industrial Applications of Atomic Energy". Further details can be obtained from the British National Committee of the World Power Conference, 201 Grand Buildings, Trafalgar Square, London, W.C.2.

An Association for Science Writers

An Association of British Science Writers has been formed. America has had a similar organisation since 1934, when the National Association of Science Writers was established.

Death of Almroth Wright

Sir Almroth Wright, pioneer of anti-typhoid inoculation died on April 30 at the age of 85. He was responsible for introducing the triple vaccine used by the British Services and known as TAB which protects against typhoid and paratyphoid.

Amalgamation of Engineering Institutions

The Institution of Mechanical Engineers and the Institution of Automobile Engineers have amalgamated, the latter title passing out of existence. The new Automobile Division of the Institution of Mechanical Engineers will enjoy a considerable degree of autonomous life—its affairs will be managed, under the general direction of the I.Mech.E. Council, by the Council of the Automobile Division elected by the Corporate Members of the Division.

U.S. Atomic Energy Appointments

The organisation of atomic energy research and development under the U.S. Atomic Energy Commission was described in the November 1946 issue of Discovery. The names of the members of the A.E. Commission we have already published (November and December 1946 issues). The membership of the General Advisory Committee has now been announced; the following are its nine members, who are appointed for six years: Dr. Robert Oppenheimer, Dr. James B. Conant, Dr. Lee Du Bridge, Dr. Enrico Fermi, Dr. I. I. Rabi, Mr. Hartley Rowe, Dr. Glenn Seaborg, Dr. Cyril S. Smith, and Mr. Hood Worthington of Dupont de Nemours. General Manager to the Atomic Energy Commission is Mr. Carroll L. Wilson. Members of the Military Liaison Committee, which will discuss with the A.E. Commission all matters relating to military applications of atomic energy, are as follows: Lt.-General Lewis H. Brereton, Rear-Admiral T. A. Solberg, Major-General Leslie Groves, Col. John H. Hinds, Rear-Admiral R. A. Ostfie and Rear-Admiral William S. Parsons.

Strict control of uranium and thorium under the A.E. Commission has been announced. Source materials subject to control, including export control, include all material which contains as much as one-twentieth of one per cent by weight of uranium, thorium or any combination of these elements. After April 1, no person unless licensed by the Atomic Energy Commission may transfer, deliver, receive title to or possession of, or export from the United States such source material after removal from its place of deposit in nature.

Personal Notes

Wing-Commander L. R. Batten, O.B.E., B.Sc., LL.B., is the new general secretary of the Chemical Society. He succeeds Dr. D. C. Martin, who has been appointed assistant secretary to the Royal Society.

The Lord President of the Council has approved the appointment of Dr. Franklin Kidd, F.R.S., Superintendent of the Low Temperature Research Station, as Director of Food Investigation, D.S.I.R. The vacancy was caused by the resignation of Dr. C. S. Hanes, F.R.S., who is taking up an appointment as Head of a Unit of Biochemistry that is being set up at Cambridge University by the Agricultural Research Council.

Dr. E. C. Bate-Smith, M.Sc., Ph.D., Senior Principal Scientific Officer at the Low Temperature Research Station, has been appointed Superintendent of the Low Temperature Research Station.

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